With METALLURGICAL SUPPLEMENT.

Engineering Library

The Engineer.

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VOL. CXLVII.—No. 3820] LONDON: FRIDAY EVENING, MARCH 29, 1929 [PRICE { WITH SUPPLEMENT } ONE SHILLING BY INLAND POST 1s. 3d.

PUBLIC NOTICES

The Director-General,

India Store Department, Belvedere-road, Lambeth, London, S.E. 1, invites TENDERS for :—

SCHEDULE 1.—44 LOCOMOTIVE BOILERS.
SCHEDULE 2.—20 LOCOMOTIVE BOILERS.

Tenders for both Schedules due on the 23rd April, 1929.

Forms of Tender available from the above at a fee (which will not be returned) of 5s. for each Schedule. 1403

Crown Agents for the COLONIES.

COLONIAL GOVERNMENT APPOINTMENTS.

APPLICATIONS from qualified candidates are INVITED for the following POSTS :—

M/1285.—ENGINEERING DRAUGHTSMAN REQUIRED by the GOVERNMENT of NIGERIA for service in the HARBOUR DEPARTMENT for two tours, each of 12 to 18 months' service, and possible extension. Salary £510, rising to £800 a year by annual increments. Free quarters and passages and liberal leave on full salary. Candidates, age 25 to 35, must be experienced in the design of reinforced concrete wharves and other structures, and should have had experience in the offices of a British Port or Harbour Authority.

M/1413.—ASSISTANT ENGINEER REQUIRED by the GOVERNMENT of TANGANYIKA TERRITORY for the PUBLIC WORKS DEPARTMENT for a tour of 20 to 30 months' service, with possible extension. Salary £480, rising to £600 a year by annual increments of £20, and thence to £720 a year by annual increments of £30. Outfit allowance of £30 on first appointment. Free quarters and passages and liberal leave on full salary. Candidates, unmarried, aged 25 to 35, must have been regularly trained as Civil Engineers, and be Corporate Members of the Institution of Civil Engineers ; must be capable of levelling, surveying, measuring up work and preparing designs of bridges, &c.; must have had at least three years' experience under a qualified civil engineer on the construction of Harbour Works, Drainage Works, Water Supply or other Public Works.

Apply at once by letter, stating age, whether married or single, and full particulars of qualifications and experience, to the CROWN AGENTS FOR THE COLONIES, 4, Millbank, London, S.W. 1, quoting the reference number against the appointment for which application is made. 1414

Shipbuilding Draughtsman's POST

under War Department at Woolwich.—APPLICATIONS INVITED from ex-Service men not over 50, with experience design and construction small craft, steam and motor Commencing salary £226 per annum, including variable-cost-of-living bonus. Suitable candidates will be required to attend Selection Board. —Full particulars and application forms from UNDER-SECRETARY OF STATE, War Office (F. 6), Whitehall, London, S.W. 1. 1394

Administrative County of LONDON.

RECONSTRUCTION OF TRAMWAYS, WHITECHAPEL HIGH-STREET.

The London County Council invites TENDERS for the RECONSTRUCTION of CONDUIT TRAMWAYS in Whitechapel High-street, and PAVING WORKS incidental thereto.

The specification, form of Tender, drawings, &c., may be obtained, on or after Tuesday, 2nd April, 1929, on application to the Chief Engineer, the Old County Hall, Spring-gardens, S.W. 1, upon payment of £5 by cheque, draft, or money order to the order of the London County Council. This amount will be returnable only if the tenderer shall have sent in a bona fide Tender and shall not have withdrawn the same. Full particulars of the work may be obtained on personal application and the contract documents may be inspected before payment of the fee.

Remittances by post should be addressed to the Chief Engineer at the Old County Hall, Spring-gardens, S.W. 1. Personal inquiries at Room 3A, No. 3, Warwick House-street, Cockspur-street, S.W. 1.

The contractor will be bound to observe the provisions of a fair wages clause, the terms of which are set out fully in the instructions for Tender and form of contract and in "The London County Council Gazette."

No Tender received by the Clerk of the Council at the County Hall, Westminster Bridge, S.E. 1, after 4 p.m. on Monday, 22nd April, 1929, will be considered.

The Council does not bind itself to accept the lowest or any Tender.

MONTAGU H. COX,
1397 Clerk of the London County Council.

West Midlands Joint Electricity Authority.

IRONBRIDGE POWER STATION.

TENDERS are INVITED by the above-named Authority for the SUPPLY, DELIVERY and ERECTION at their Ironbridge Power Station of all or any one or more of the following complete sections of Work :—

SECTION 1.—ONE 50,000-Kilowatt TURBO-ALTERNATOR, with STEP-UP TRANSFORMERS, &c.

SECTION 2.—CONDENSING PLANT, BOILER FEED PUMPS, EVAPORATORS, &c.

SECTION 3.—CIRCULATING WATER PUMPS, &c.

Copies of specification (No. 2) and form of Tender may be obtained from Mr. E. F. Hetherington, M.I.E.E., M.I. Mech. E., Chief Engineer and Manager, at the offices of the Authority, on payment of a deposit of Two Guineas, which will, after the Authority have come to a decision upon the Tenders received, but not before, be returned to the tenderer, provided he shall have sent in a bona fide Tender and shall not have withdrawn it. Additional copies of the specification may be obtained on payment of One Guinea per copy, which will not be returned.

Tenders must be forwarded under sealed cover, endorsed "Tender for Contract No. 2, Ironbridge Power Station," so as to reach the undersigned not later than Noon on Friday, the 10th May, 1929.

The Authority do not bind themselves to accept the lowest or any Tender.

H. F. CARPENTER,
Clerk and Treasurer.

Offices of the Authority :
Phœnix Buildings,
Dudley-road, Wolverhampton,
20th March, 1929. 1392

The Engineer

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West Midlands Joint Electricity Authority.

IRONBRIDGE POWER STATION.

TENDERS are INVITED by the above-named Authority for the SUPPLY, DELIVERY and ERECTION at their Ironbridge Power Station of E.H.T. SWITCHGEAR, &c., comprising :—

(A) MAIN 33,000-VOLT SWITCHGEAR, each circuit breaker having a rupturing capacity of not less than 1,500,000 kVA.

(B) AUXILIARY 33,000-VOLT SWITCHGEAR, each circuit breaker having a rupturing capacity of not less than 500,000 kVA. together with Group Feeder Reactors.

Copies of specification (No. 4) and form of Tender may be obtained from Mr. E. F. Hetherington, M.I.E.E., M.I. Mech. E., Chief Engineer and Manager, at the offices of the Authority, on payment of a deposit of Two Guineas, which will, after the Authority have come to a decision upon the Tenders received, but not before, be returned to the tenderer, provided he shall have sent in a bona fide Tender and shall not have withdrawn it. Additional copies of the specification may be obtained on payment of One Guinea per copy, which will not be returned.

Tenders must be forwarded under sealed cover, endorsed "Tender for Contract No. 4, Ironbridge Power Station," so as to reach the undersigned not later than Noon on Friday, the 10th May, 1929.

The Authority do not bind themselves to accept the lowest or any Tender.

H. F. CARPENTER,
Clerk and Treasurer.

Offices of the Authority :
Phœnix Buildings,
Dudley road, Wolverhampton,
20th March, 1929. 1391

Great Northern Railway (IRELAND).

APPOINTMENT OF CHIEF ENGINEER.

The Company REQUIRE the SERVICES of a fully qualified RAILWAY ENGINEER.

Applications, giving particulars of experience and stating age and salary expected, should be sent accompanied by copies of testimonials, under private cover, to the undersigned not later than April 20th.

F. C. WALLACE,
Secretary.

Amiens-street Station, Dublin,
25th March, 1929. 1390

PUBLIC NOTICES

CIVIL SERVICE COMMISSION.

POSITION VACANT.—EXAMINER OF APPLICATIONS FOR PATENTS OF INVENTIONS.

The Civil Service Commissioners

invite APPLICATIONS for the whole-time, permanent pensionable POSITION of EXAMINER of APPLICATIONS for PATENTS of INVENTIONS (chiefly chemical) in the Industrial and Commercial Property Registration Office, Department of Industry and Commerce. Salary scales :—Married man, £150-£350 ; woman or unmarried man, £130-£250 per annum, plus cost-of-living bonus in each case. At present the bonus on £150 is £94 14s., and on £130 is £87 7s. Good general education, particularly in science and mathematics, and a knowledge of industrial chemistry required. Age limits 25 to 40 years.

Latest date for receipt of applications 6th April, 1929. Forms and particulars may be obtained from the SECRETARY, Civil Service Commission, 33, St. Stephen's Green, Dublin. 1382

24/A. 2353. W.H. Co.

City of Leicester Water DEPARTMENT.

TEMPORARY ENGINEERING ASSISTANT.

The Water Committee are prepared to receive APPLICATIONS for the POST of TEMPORARY ENGINEERING ASSISTANT on the Design and Construction of a Pipe Line, 12 miles long, and works in connection therewith.

The salary paid will be at the rate of £500 per annum.

Applications, stating age, experience, qualifications, and present salary, together with copies of not more than three recent testimonials, will be received by me not later than Noon on April 8th, 1929.

Preference will be given to Corporate Members of the Institution of Civil Engineers.

Canvassing members of the Committee will disqualify applicants.

G. T. EDWARDS, M. Inst. C.E.,
Engineer and Manager.

Waterworks Office,
Bowling Green-street, Leicester. 1350

PUBLIC NOTICES

Bedwellty Union.

APPOINTMENT OF ENGINEER.

The Guardians of the above Union invite APPLICATIONS from single men or widowers, without dependants, for the APPOINTMENT of a RESIDENT WORKING ENGINEER at the Union Institution at Tredegar.

Candidates must possess a practical knowledge of Boilers, Heating and Cooking Apparatus, Laundry Machinery, Electric Lighting and Power, General Plumbing, Motor Cars, Fire Appliances and General Repairs.

Salary £105 per annum, rising, subject to satisfactory service, by annual increments of £5 to £120 per annum, with lodging and washing and an allowance of 15s. weekly (subject to alteration at the discretion of the Guardians) in lieu of rations, subject to the provisions of the Poor Law Officers' Superannuation Act, 1896.

Applications, in candidates' own handwriting, with copies of three recent testimonials, on forms which may be obtained by forwarding me a stamped addressed foolscap envelope, must reach me not later than 10 a.m. on Monday, the 8th April, 1929.

WILLIAM HALL,
Clerk to the Guardians.

Union Offices,
Tredegar, Mon.,
20th March, 1929. 1398

SOAG MACHINE TOOLS, Ltd., 45, Horseferry-road, London, S.W. 1, who have advertised in our columns for a considerable time, were inadvertently OMITTED from the APPROPRIATE HEADINGS in the recently published edition of "'THE ENGINEER' DIRECTORY." The FIRM MANUFACTURE a LARGE RANGE of MACHINE TOOLS and inform us that they are the LARGEST STOCKISTS in EUROPE of SURPLUS, NEW and SECOND-HAND MACHINE TOOLS. 1405

SITUATIONS OPEN

COPIES OF TESTIMONIALS, NOT ORIGINALS, UNLESS SPECIFICALLY REQUESTED.

WANTED, BLAST-FURNACE MANAGER, to Take Control of Blast-furnace Plant producing high grade basic pig iron. Must be thoroughly up to date and fully conversant with latest methods of manufacture. Splendid opportunity for the right individual.—Reply, with full particulars of experience, references, and salary required, to the SECRETARY, The Partington Steel and Iron Co., Ltd., Irlam, Manchester. 1381 A

WANTED, ESTIMATING ENGINEER, with Experience of Preparing Schemes embodying Air Compressors and Vacuum Pumps, who could undertake own layout drawings, &c., Commencing salary £250 p.a., with good prospect of advancement. London office.—Address, 1393, The Engineer Office. 1393 A

WANTED for Colliery Plant Manufacturers in South Wales, JUNIOR ESTIMATOR, age about 25.—Address, giving experience and wages required, 1390, The Engineer Office. 1390 A

WANTED, for Oilfields in Iraq (Mesopotamia), young ENGINEERS, age 21-25, unmarried, secondary school education and technical classes (or better), with experience in some of the following :—Steam Engines, Internal Combustion Engines, Electrical Motors and Generators, Boiler Shop, Smithing, Machine Shop, Outside Construction, Erection of Machinery, Drawing-office.

Applications, in own handwriting (NO ORIGINALS of testimonials, &c., to be sent), to TURKISH PETROLEUM COMPANY, Ltd., King William-street House, London, E.C. 4. 1411 A

WANTED IMMEDIATELY, for a British Structural Works in India, a HEAD DESIGNER ; man with commercial experience preferred. Must have good knowledge of Steel Bridge Work designing. Remuneration the equivalent of £2000 per annum, with excellent prospects for the right type of man. Age between 33 and 40.—Write, with copies of testimonials and photograph, to Z.A. 761, c/o Deacon's Advertising Agency, Fenchurch-avenue, London. 1396 A

WANTED, Young ENGINEER, Preferably either just from university or with few years' Sales Engineering experience. Fluent French essential and good knowledge either German or Spanish, but preferably both. Permanent employment with ample scope for advancement for right man. Full particulars as to age, education, training, and experience by letter.—Address, 1381, The Engineer Office. 1381 A

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SITUATIONS OPEN (continued)

ASSISTANT CIVIL ENGINEER, Aged 30-35, REQUIRED for position abroad in Central Office controlling Branch Depots.
Must be an Assoc. M. Inst. C.E., be able to design Steel and Reinforced Concrete Buildings and Small Jetties and have experience of Boilers, Pumps, Pipe Lines, &c. Knowledge of a foreign language an advantage. Good salary paid to competent man.
Write, with copies of three testimonials and giving full particulars of training, to Box M. 750, Willing's, 133, Moorgate, E.C. 2. P5681 A

CHARGE ENGINEER REQUIRED for Tannery in South-East England, to Take Charge of Mechanical and Electrical Plant and General Works Maintenance. Must have experience of installation and maintenance of A.C. Motors, Transformers, Switchgear, &c. Preference given to men with previous experience in a tannery. Salary about £5 per week.—Address, giving age, experience, &c., 1401, The Engineer Office. 1401 A

COST and GENERAL CLERK WANTED for Light Constructional Engineer's Office in London. Experienced in costing and charging up jobs, &c.—Address, stating age, qualifications, and salary asked, P5686, The Engineer Office. P5686 A

ENGINEER REQUIRED by Well-known Eastern Merchants in South India. Applicants must have good practical knowledge of Engines and Machinery, be experienced as draughtsmen and designers and be capable of preparing estimates and attending to office correspondence; electrical knowledge if possible. Age 22 to 27, single. First agreement 3 years, subsequent agreements 4 years, with six months' furlough on full pay between each agreement. First-class passage. Outfit allowance.—Address, 1406, The Engineer Office. 1406 A

ENGINEERING.—A GRADUATE with First-class Honours is REQUIRED to revise correspondence courses and correct students' answers in engineering subjects. About ten hours' work per week will be wanted.—Apply, "ENGINEERING," University Book Company, 47, Great Russell-street, London, W.C. 1. 1373 A

FIRM of CHARTERED PATENT AGENTS REQUIRE a TECHNICAL ASSISTANT capable of dealing without supervision with the preparation and prosecution of applications in this country and Continental Europe. Preference will be given to an unmarried man of between 25 and 30 years of age possessing personality in addition to the requisite technical ability, and to a suitable applicant a progressive position with excellent prospects can be offered. Although it is desirable that applicants should have passed the qualifying examination of the Institute, it is not essential. Replies should state fully every particular which the applicant considers will assist the advertisers to make a selection.—Box 642, c/o Judd's, 47, Gresham-street, E.C. 2. 1337 A

JUNIOR CIVIL ENGINEERING DRAUGHTSMAN REQUIRED temporarily in Railway Engineer's Office in London, with experience in General Constructional and Building Work.—Address, stating age, experience, and salary required, 1400 The Engineer Office. 1400 A

STEEL WORK DESIGNER REQUIRED by Constructional Engineers in London. Permanent post to right man. Similar experience essential. Give full particulars of same, also age and salary required, &c.—Address, 1408, The Engineer Office. 1408 A

TECHNICAL SALESMAN REQUIRED to Promote educational campaign and co-ordinate branch effort for the sale of a high-class Insulating Brick. Only those with an organising ability and definite connection amongst furnace builders, potteries, &c., need apply. Fullest particulars, including age and salary required, must be stated, which will be treated in strictest confidence. Advertisers are a large and old-established firm.—Address, 1402, The Engineer Office. 1402 A

THE EBBW VALE STEEL, IRON and COAL CO., Ltd., REQUIRES a JOINT CHIEF ENGINEER, to Take Charge of the Outside Work on Maintenance and New Work in the Iron and Steel Section of their operations. Applications to be sent to the SECRETARY, General Offices, Ebbw Vale, giving age, education, technical training, experience, references, and salary required. Applications will be treated with strict confidence, but only those giving all the particulars asked for will be considered. 1413 A

YOUNG OUTSIDE ENGINEER for Algeria, Age 25-30, preferably single, to Supervise Running of Aerial Ropeway 5 miles long. Previous ropeway experience not essential. Some knowledge of French desirable. Send full details previous experience.—Address, P5677, The Engineer Office. P5677 A

WANTED, a DRAUGHTSMAN, Experienced in Hydraulic Machinery, particularly Cranes and Hoists.—Apply by letter only, stating age, experience, and rate of pay required, HYDRAULIC ENGINEERING CO., Ltd., Chester. 1388 A

CHIEF DRAUGHTSMAN WANTED, to Take Charge of Small Drawing-office consisting of component and jig and tool sections. Must be qualified to supervise design of office machinery and have had experience in allied manufacture.—Address, stating age, experience, and salary required, 1387, The Engineer Office. 1387 A

DETAILING DRAUGHTSMEN REQUIRED by London Structural Engineers. Applicants should have previous experience of similar work. State age and salary required, &c.—Address, 1409, The Engineer Office. 1409 A

DRAUGHTSMAN for Heavy Oil Engines, Land Type.—Address full particulars, age, and salary required, 858, The Engineer Office. 858 A

DRAUGHTSMAN for London Office, to Detail Light Structural Steel Work, &c. Knowledge Bunker and Hopper Work desirable, but not essential. State salary required.—Address, 1412, The Engineer Office 1412 A

DRAUGHTSMAN (Not Junior) for Pumping Machinery, Reciprocating and/or Centrifugal.—Address, stating age, experience, salary required, 857, The Engineer Office. 857 A

DRAUGHTSMAN, with Some Electrical Designing experience, REQUIRED; country works. Applicants must give full particulars of experience and qualifications, also state age and salary, to Box H620, c/o Haddon's, Salisbury-square, London, E.C.4. 1314 A

DRAUGHTSMEN, First-class Senior Men, REQUIRED, preferably with Aero-engine experience.—Address, stating age, full experience, and salary required, 1410, The Engineer Office. 1410 A

HEATING DRAUGHTSMAN REQUIRED, Fully experienced and capable of designing and estimating large centralised schemes.—Apply in writing, giving details, age, and salary required, to THE BRIGHTSIDE ENGINEERING CO., 17, Summer-row, Birmingham. 1390 A

MACHINE TOOL DRAUGHTSMAN WANTED for Machine Tool Design. Applications are only invited from men of first-class ability.—Address, "DESIGN," Wm. Porteous and Co., Advertising Agents, Glasgow. P5632 A

REQUIRED IMMEDIATELY for South Wales District, a capable DRAUGHTSMAN, thoroughly accustomed to Steel Works Rolling Mills. Must be able to prepare schemes for a new mill layout and later all necessary working drawings. None but men with first-class knowledge should apply, stating age, experience, and salary required.—Address, 1339 The Engineer Office. 1339 A

THE CHATWOOD SAFE CO., Ltd., Shrewsbury, REQUIRE the SERVICES of a SENIOR and JUNIOR DRAUGHTSMAN trained in Mechanical Engineering.—Applications by letter, stating qualifications, experience, age, and salary required, to "TECHNICAL DIRECTOR." 1320* A

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HERBERT

ENGINEERING FINANCE.

THE fundamental necessity of modern equipment is realised by all progressive engineers—but it frequently happens that, owing to financial considerations, old plant is retained in service long after it has become obsolete and that the purchase of up-to-date machinery is deferred to some indefinite time in future.

Our Financial Department is prepared to deal with cases of this kind and to facilitate the modernisation of engineering workshops and the putting down of new machinery, either of *our own or of any other approved make.*

All communications will be treated confidentially and should be addressed to:—

Financial Director,
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AH

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The Production & Treatment of Vegetable Oils.

Including chapters on the Refining of Oils, the Hydrogenation of Oils, the Generation of Hydrogen, Soap Making, the Recovery and Refining of Glycerine, and the Splitting of Oils.

By T. W. CHALMERS, B.Sc., A.M.I. Mech. E.
(Of the Editorial Staff of "THE ENGINEER.")

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CONSTABLE & CO., Ltd., 10, Orange Street, London, W.C.2.

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Complete absence of complications
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Renewable valve and seat in special non-corrodible steel
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HOLDEN & BROOKE Ltd Sirius Works, West Gorton MANCHESTER
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MACHINE TOOLS AND CRANES.

FOR OUR ILLUSTRATED ADVERTISEMENT SEE LAST WEEK'S AND NEXT WEEK'S ISSUES.

LARGE SPAN ROOFS!

HERE is evidence of our ability to undertake the big structural engineering job:—
The illustration shows Large Span Roofs for a Shipyard Platers' Shop, total length, 387 feet; total width, 360 feet.
In three clear spans of 120 feet each.
Total weight of Structural Steel, about 1,000 tons.
We have unique facilities for prompt bridge building and repairs without disturbing rail traffic.
Our Engineering Dept. is also engaged in making Railway Wheels and Axles, Buildings, Transmission Towers and Masts, Oil Storage Tanks and Chimneys, Coal Handling and Screening Plant, Blast Furnaces, etc.

MILLS & FORGES.

Makers of Iron and Steel Hoops and Bars, Steel Wire Rods, Cold Rolled Hoops and Cable Armour Tape.

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We invite your enquiries for further information.

The PEARSON & KNOWLES COAL AND IRON CO·LTD

WARRINGTON ENGLAND

P&K

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W·I·W STEEL WIRE RODS
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WHEELS & AXLES
W·I·W IRON & STEEL HOOPS
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BLAST FURNACES
BNF IRON & STEEL BARS
CABLE ARMOUR TAPE

P&K

M.C. 1.

A Seven-Day Journal

The British Mission to Russia.

ON Monday the delegation organised by the Anglo-Russian Committee with the object of promoting trade between this country and Russia left London for Moscow. The delegates number eighty-five, and represent 150 firms and trading organisations. During their stay in Russia, they will be the guests of the Soviet Government. Conversations on trade will begin on Monday next, and will be carried on in sections devoted to particular industries or groups of industries. It is expected that the delegation will remain in Russia for three or four weeks. On its return it will prepare a report, which, it is hoped, will render possible an important extension of British trade in Russian markets. The question of credits and of Russia's financial resources will form important subjects in the discussions. The delegation covers practically the whole of British trade and industry, and its members are all experts in their particular branches. The inquiry will be conducted on an entirely non-political basis. A list of the firms and associations represented on the delegation reveals the fact that quite half of the members are connected with the engineering industry.

The Post Office and Motor Transport.

AT the present moment this country's postal services are carried on with the aid of about 2300 motor vehicles hired from contractors, at an annual cost of about £562,000, and of about 2320 officially owned motor vans and motor cycles, on which approximately £650,000 is expended per year. The second-named sum, it has to be noted, includes expenditure on certain services additional to those formerly worked by the contractors' vehicles. It is understood that the Post Office is preparing plans for a great extension of the officially owned fleet of transport vehicles. A few of the vans at present in use are electrically propelled, and experiments are being made with a view to the possible extension in the number of such vehicles employed. It was not until 1919 that the British Post Office became an owner of postal transport vehicles. In 1924 solo motor vehicles were introduced. These vehicles have proved very efficient for rural delivery and collection work, and a large extension of their use is stated to be certain. The 2320 vehicles at present owned by the Post Office are based on 450 different towns or villages. They are operated by over 4000 postmen-drivers and about 150 tradesmen-drivers. It is said to be the intention of the Post Office to train additional numbers of postmen to act as drivers, in addition to carrying on their ordinary postal duties.

Naval Construction on the Tyne.

ON Friday last, March 22nd, the new 10,000-ton cruiser H.M.S. "Sussex" left the Tyne for Chatham, after undergoing satisfactory acceptance trials. She was built and engined by Hawthorn, Leslie and Co., Ltd., and her geared turbine machinery is designed to give her a speed of 32¼ knots. Her armament comprises eight 8in. guns, anti-aircraft guns, quick-firing guns, and torpedo equipment. The "Sussex" was launched in February, 1928, about a year after her keel-plate was laid, and her builders must be congratulated on completing her in a little over a further year. The new cruiser is of the "London" class, and will join the Mediterranean Fleet in place of the cruiser "Danae," which is to undergo an extensive refit. It is of interest to record that Hawthorn, Leslie and Co., Ltd., have recently completed an improved type of mine-sweeper, H.M.S. "Bridgewater," for service in the East, and that a sister ship, H.M.S. "Sandwich," was also completed and ran acceptance trials last week. The firm has also in hand two destroyers, which were ordered at the same time as H.M.S. "Sussex," and two others for which the order was placed about two weeks ago.

The Harwich-Zeebrugge Train Ferry.

SIXTY years and more ago, when plans for the improvement of cross-Channel communication between this country and France were being actively debated, the provision of a train ferry service was strongly advocated as an alternative to a tunnel, bridge, or embankment. Since then, when the subject has been given fresh consideration, attention has been almost wholly concentrated upon schemes involving the construction of a tunnel. While we may dismiss the bridge and embankment schemes as impracticable, the train ferry proposal can still be regarded as a reasonable alternative to a tunnel. At the sixth annual general meeting of Great Eastern Train Ferries, Ltd., held in London on Monday, the chairman, Lord Daryngton, suggested that a Channel train ferry would be enormously cheaper to establish than a railway connection through a tunnel. If a train ferry service would meet the case, he would urge that all concerned should remember that Great Eastern Train Ferries had already acquired much experience in the operation of such a service. The company, he added, would be very glad to co-operate with the railways on both sides in the establishment of a Franco-British train ferry service. The company's Harwich–Zeebrugge train ferry services were carried on uninterruptedly throughout the whole of last year. The net profits amounted to £22,129, as compared with £21,024 in 1927. There was a reduction of 22,500 tons in the volume of heavy traffic, such as building materials, handled by the ferries, but that falling off was, in part, offset by an increase of 9300 tons of a more remunerative traffic. During the past 4½ years the ferries have dealt with about 560,000 tons of cargo in over 70,000 loaded goods wagons. In addition, several hundred passenger coaches have been shipped and landed, in most cases in the fully equipped condition.

The Lots Road Power Station.

WITH a view to augmenting the efficiency and capacity of the Lots-road Power Station, the London Underground Companies are carrying out a scheme of improvements. During recent years extensions of the lines, increased train services, and more powerful rolling stock, new and re-modelled stations, &c., have necessitated an increased current supply, which has been met to some extent by the installation of new machines in the power station. The probability of further extensions of the system in the near future, still further improvements in the train service and other improved facilities has caused the company to increase the capacity of the station, and at the same time completely overhaul and modernise the plant. In brief, the work involves the provision of nine modern turbo-alternators, thirty-two new boilers, a new and improved switchboard, an increase of the circulating water supply, and the provision of ash-removing plant and grit arresters. Each of the new turbo-alternators will have a maximum continuous output of 18,750 kilowatts. The new machines will be of the same design as the later machines now in use, and they will bring the installed maximum capacity of the station up to 168,000 kilowatts. The remaining 6000 kilowatt machines installed in 1906 will be scrapped. No fewer than sixty-four old boilers will be replaced by a smaller number of boilers of four times the capacity and working at higher steam pressure and temperature. The control switchboard now in use is situated on an open gallery in the turbine room, but a new and larger switchboard has been erected in a special room away from the noise, bustle and heat.

New Motor Lifeboats.

IN view of Mr. J. R. Barnet's paper on motor lifeboat progress at the last meeting of the Institution of Naval Architects, held on Friday afternoon last, to which reference will be made in a later issue, it is of interest to record that four of our leading shipping companies have recently given three lifeboats for the service of the Royal National Lifeboat Institution. The P. & O. group of companies, through Lord Inchcape, have given the sum of £14,500 to provide a large motor lifeboat which will be stationed at Padstow, Cornwall. Through Lord Kylsant, the Royal Mail Steam Packet Company and the Union-Castle Mail Steamship Company have given jointly the sum of £6500 to build a Watson type lifeboat, which will be stationed at Weymouth. A slightly larger boat of the same type is being built at a cost of £8500 for Fishguard. She is being presented to the Institution through Lord Kylsant by the White Star Company. The suggestion has been put forward that these gifts might prove an incentive to further gifts by some of the London shipping exchanges. Meanwhile, work is proceeding on the design of new motor lifeboats and engines for propelling them, and we understand that the tests on a new type of 1½-litre petrol engine, specially designed by the Institution's engineers for lifeboat duty, will shortly be made.

Salvage Work at Scapa Flow.

IT is with pleasure that we learn that on Thursday of last week, March 21st, the 24,500-ton ex-German battleship "Kaiser," which sank upside down in 25 fathoms of water near the "Hindenburg" in Scapa Flow, was successfully floated by Cox and Danks, Ltd. Preliminary work on the upturned hull, which has a water line length of 564ft. and a width of 93ft. 3in., was begun at the end of August last year, and as weather conditions have allowed, the openings in the hull have been sealed up with concrete, enabling air locks to be fitted and air pressure to be applied to the internal spaces. The various engine and boiler-rooms have been explored under compressed air, and air leaks made good to the required depth. The bow of the ship was first raised, and then lowered, and finally the stern was lifted and the air pressure regulated to preserve a fairly level keel. When on Thursday of last week the underside of the hull—that is the deck—was examined by divers, it was found that the vessel was quite clear of the bottom, and it only remained to blast away parts of the crumpled funnels and masts and certain hindrances which prevented the towing of the ship. These operations were completed on Friday evening, and towing was then begun. After three hours' effort, the firm's tugs moved the ship its own length, and she will now be towed to Lyness Pier, about 3 miles distant. As the weather was broken on Saturday towing was suspended, and it may be necessary during the voyage to ground the ship on a sand bank, as was done in the case of the "Seydlitz" and raise her still higher out of the water before beaching her alongside the pier at Lyness. It is expected that both the "Seydlitz" and the "Kaiser" will be towed to Rosyth Dockyard, for breaking up. We are given to understand that in all about two months were lost owing to work being suspended on account of bad weather. This being so, the ship was raised after less than five months' work had been done upon her.

Weather Charts by Wireless.

IN the course of the G. J. Symons Memorial lecture, delivered by Mr. R. A. Watson Watt, on Wednesday, March 20th, before the Royal Meteorological Society, South Kensington, it was announced that daily weather charts are to be transmitted by wireless from Daventry. The transmissions, it seems, are to be experimental, and the Fultograph system is to be employed. Wireless as a means of communication, Mr. Watt explained, was essential in modern meteorology, because it alone was capable of giving sufficiently rapid interchanges of data over wide areas. In British meteorology it was of special importance, because it carried data from ships in the Atlantic, giving the first indications of impending changes from the west. In aerial navigation it provided the only means of conveying forecasts and the data necessary for the intelligent use of forecasts. The results of observations made all over Great Britain were in the hands of the central forecaster within an hour, the bulk of the data for Europe was received within an hour and a-half, and for the whole Northern Hemisphere within six hours. Wireless, the lecturer pointed out, had a climate and weather of its own. The weakening of signals over different kinds of country, according to the time of day and season, and the dependance of atmospheric disturbances on latitude, place and time, were climatological in scope. The quick period changes and the erratic phenomena of fading were part of the weather of wireless, while atmospherics represented its rainfall.

Fire on New North German Lloyd Liner.

IN the early hours of Tuesday, March 26th, fire broke out on the new North German Lloyd Atlantic liner "Europa," which was fitting out at Messrs. Blohm and Voss's yard at Hamburg. At the time of the outbreak it would appear that only the watchmen were aboard, and the fire, which apparently began in the forward part of the ship, rapidly gained a hold amidships. In spite of the attendance of fire floats and fire engines, considerable damage was done, which is estimated at close upon £1,000,000. The fire was not under control until Tuesday evening, and it is understood that all the upper decks and superstructure are seriously damaged. The builders report that the engine and boiler rooms have not been damaged and there is no danger of the vessel capsizing or sinking. At ten o'clock on Tuesday morning the water which had been poured aboard the ship gave her a list to starboard, but with the ebbing of the tide the ship settled down on the floor of the harbour. The fire is, we believe, one of the most serious in the annals of shipbuilding, and the delay in the owners' programme of fast Atlantic services, which was to be begun in July, will be a very serious one. It is understood that building risks were covered by large insurances effected in Germany and in London. The keel of the "Europa" was laid in July, 1927, and the ship, along with the sister liner the "Bremen," was launched last August. Work on these liners has been delayed on account of the recent shipbuilding trouble in Germany, but it was expected that both ships would be ready for trial in the early summer.

Kapok.

IN 1901 the Royal National Lifeboat Institution adopted kapok, a vegetable down, as a filling material for lifebelts, and some years later the Board of Trade adopted it for the same purpose in the mercantile marine. In the report of the Court of Inquiry appointed in connection with the Rye lifeboat disaster, it was stated that the lifebelts stuffed with kapok which were worn by the crew appeared to have absorbed an extraordinarily large amount of water. It was suggested that further inquiry should be made as to whether kapok was the best material to use under all conditions and in all circumstances. It was announced this week that the Board of Trade had appointed Admiral Sir Henry Oliver, Captain H. B. Pope, Captain H. F. J. Rowley, Captain Luke Ward, and Sir Thomas Stanton as a Committee to examine the Court's statements and recommendations and to advise as to whether alterations should be made in the rules and practice with regard to the use of kapok in life-saving appliances. Kapok is the seed hair of a tree which is common in the West Indies, Malaya, and parts of Africa. The material, by reason of its structure, is unsuitable for textile purposes. It has, however, considerable power to resist the penetration of water. An authority states that a jacket containing 700 grams of kapok stuffing was found to have a floating power of 10·5 kilos. After 72 hours in water with a weight of 9 kilos. attached to it, the jacket still required 1·3 kilos. more to sink it. After 192 hours the weight required was 0·9 kilos. The seed kernels from which the hair is obtained yield about 25 per cent. by weight of a valuable soap-making and edible oil.

The London Power Company.

No. VII.*

THE DEPTFORD EAST STATION.

ON account of its history the Deptford East station of the London Power Company is one of the most interesting power stations in the world. Its origins carry back to the earliest days of electric lighting, and its conception showed a prescience of the form which electrical development would take that is little short of marvellous, considering the state of the art at the time. It arose from the success of a portable electric lighting plant put down in the year 1883 by the late Sir Coutts Lindsay to light the Grosvenor Gallery in New Bond-street. The numerous applications of people in the neighbourhood for a supply of electricity resulted in the construction of a small power station underneath the gallery. From this station, which had a capacity of 1000 kilowatts, single-phase alternating current at a pressure of 2500 volts was transmitted by overhead lines over an area extending from Regent's Park in the north to the Thames in the south, and from Knightsbridge in the west to the Law Courts in the east. There were about 30,000 lamps connected to this system. The demand for electricity increased so rapidly that, in 1887, the London Electric Supply Corporation was formed, with a capital of £1,000,000. Dr. S. Z. de Ferranti, then a very young man, who had been managing the Grosvenor Gallery station, had a vision of the future which might truly be called prophetic. He advised the new company to embark on bold lines; to build a really large station at Deptford, well outside London where land was cheap, where an unlimited supply of condensing water was available, and where sea-borne coal could be obtained at low prices. The scheme involved the transmission of the electricity to London at the then unheard-of pressure of 10,000 volts, and for this reason it was severely criticised by leading engineers in all parts of the world, including Mr. Edison, who visited the Deptford station in October, 1889.

The boldness of Dr. Ferranti's ideas was only equalled by his energy and resource in carrying them out. No firm could be found to undertake the manufacture of the 10,000-volt cables required, so Dr. Ferranti designed them himself and had them made by the company on its own premises. The conductors consisted of two concentric copper tubes, each with a sectional area of 0·25 square inch, separated by a radial thickness of 0·5in. of paper insulation impregnated under pressure with ozokerite wax. The cable was made in lengths of 20ft., and altogether about 28 miles of it were laid and ran satisfactorily for years at a pressure of 10,000 volts, in spite of the thousands of joints involved in the construction. Some of this cable, which was the pioneer of all the high-tension paper-insulated cables in the world, has remained in service until the present day.

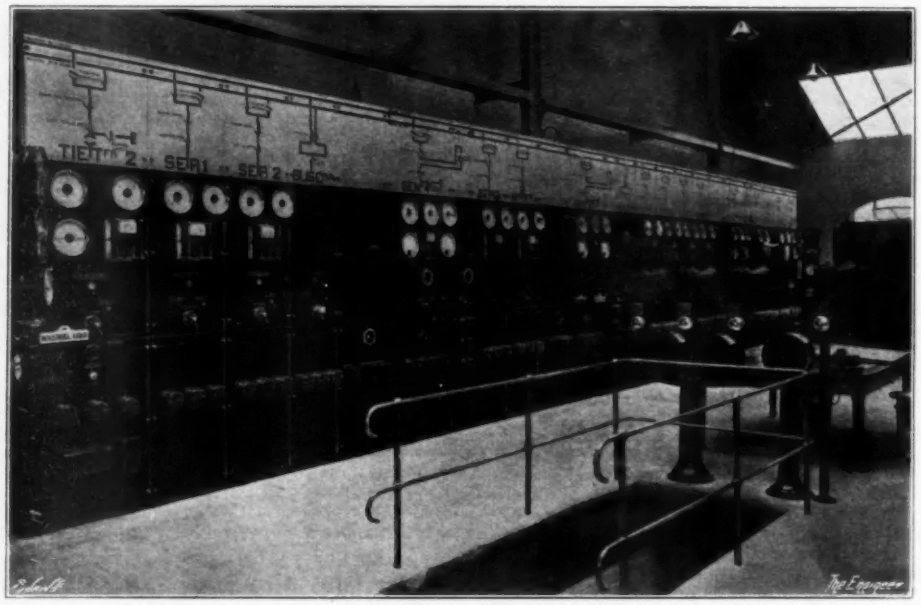


FIG. 28—DEPTFORD EAST—CONTROL SWITCHBOARD

The first generating machinery to be installed at Deptford was that which had served at the Grosvenor Gallery station. The alternators were of the Ferranti type, the first being driven by belts from three Marshall engines of 250 H.P., 250 H.P., and 400 H.P. respectively. The engines could be connected by clutches as the load required, all three engines being clutched in to drive the alternator at full load. The other generator was driven by ropes from a 750 H.P. Corliss engine, built by Hick, Hargreaves and Co. The generators were at that time the largest in the country. They had armatures 8ft. 6in. diameter, running at 250 revolutions per minute and produced single-phase current at 2500 volts, this pressure being increased to 10,000 volts for transmission by step-up transformers. Their frequency was 83⅓ cycles per second, the seeming oddness of this figure being explainable by the fact that it corresponds to 10,000 reversals of the current per minute, which was the way in which frequency was considered in those days. The units mentioned were used to give a supply during the early days of the station, but in 1889 two 10,000-volt Ferranti alternators were installed. These were rope driven by 1500 H.P. Hick, Hargreaves vertical engines, which engines were running on load as late as 1923, and giving economical and satisfactory service. When they were built, these sets were by far the largest generating units in the world, but Dr. Ferranti saw no reason to limit himself to such sizes. The Deptford site had been laid out for an ultimate capacity of 120,000 H.P., and to develop this power in a reasonable number of units, engines much larger than 1500 H.P. were necessary. In 1889 Dr. Ferranti therefore designed units of 10,000 H.P. each, running at 60 revolutions per minute. The construction of one of these immense sets, of which the generator alone weighed 500 tons and had an armature 46ft. in diameter, was actually commenced, but owing to various reasons the work was discontinued and the sets were never put into service. It was not only by the soundness of its fundamental principles and the boldness of its conceptions that Deptford assisted so greatly in the development of central station engineering. Present-day electrical practice owes more than is generally recognised to the work of the Deptford engineers, notably the invention of the oil-immersed circuit breaker by Mr. G. W. Partridge in 1892. In the same year a 10,000-volt switchboard was erected, which has been running for more than thirty-five years without failure. Cable-charging gear, for safely switching high-tension cables in and out of circuit was another contribution to practice made by Deptford, although with cables of modern design it is now rarely considered necessary.

We must now leave these days of pioneering and come to more modern times. In the year 1912 the engine-room was completely filled with old reciprocating units of an aggregate capacity of 16,000 kW, some of which had done duty for more than thirty years. They ran with steam at a pressure of 210 lb. per square inch and without superheat. One by one they were removed, and the same building now houses nine turbines, of an aggregate capacity of over 100,000 kW. An equally complete transformation has taken place in the boiler-house, the pressure being raised to 325 lb. and the temperature to 750 deg. Fah. at the boiler junction valves. In the same time the power generated has increased from 32 millions to over 222 million units per annum. Deptford suffers somewhat from a heritage of the past. It still has to supply a certain amount of single-phase current at 83⅓ cycles for lighting purposes, and to this end has three turbo-alternators of 4000-kW capacity and one of 7500-kW capacity, generating at 2500 volts. The rest of the plant is three-phase, but even so, it is complicated by differences of frequency and voltage. For the ordinary industrial load there are two machines of 8750 kW and 15,000 kW respectively, generating three-phase current at 6600 volts and 25 cycles, and for the Southern Railway service there are three 20,000-kW sets, generating three-phase 25-cycle current at 11,000 volts. A further set of 25,000-kW capacity will probably be installed in the near future for the growing needs of the railway service. All the three-phase generators are so constructed that they can be run as single-phase machines, thus enabling a supply of single-phase 25-cycle current to be given when required to the single-phase section of the Southern Railway. They can also be run in parallel with the London County Council power station at Greenwich, so that mutual aid may be given if required. A view of part of the turbine-room is shown in Fig. 33, page 354.

FIG. 29—DEPTFORD EAST—FIRING AISLE

FIG. 30—DEPTFORD EAST—ASH HOPPERS AND SLUICES

The turbines all take steam at a pressure of 300 lb. per square inch and a temperature of 700 deg. Fah. at the stop valves. They are bled at two points, steam at a comparatively high pressure being passed out for the evaporators, of which one is connected to each main unit, lower pressure steam being taken for the de-aerators. The system of "closed feed" in use at Deptford was originated in the station at a time when probably no complete closed feed system had ever been developed elsewhere, and thus affords one

* No. VI. appeared March 22nd.

more example of the enterprise which has characterised Deptford engineering. The principle is as follows:—The condensate after being removed from the condenser by the extraction pump is pumped into a de-aerator of the flash type, in which it comes into contact with the low-pressure steam bled from the turbine. Air is removed by a connection to the condenser, and the air-free water is heated by the steam to a temperature corresponding to the vacuum. The action is practically automatic, the temperature and vacuum being nearly constant at all loads. A booster pump extracts the water from the de-aerator and delivers it under pressure to the suction of the

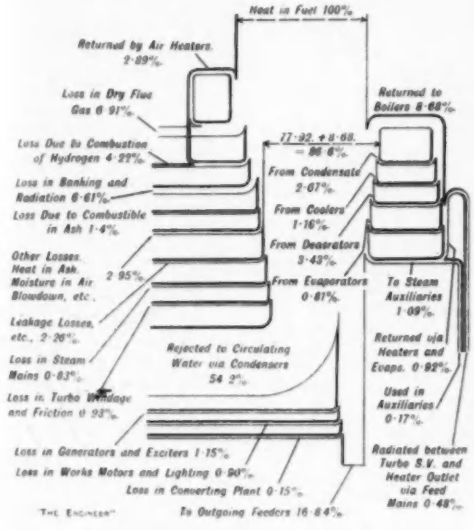

Heat in Fuel 100%
Returned by Air Heaters 2·89%
Loss in Dry Flue Gas 6·91%
Loss Due to Combustion of Hydrogen 4·22%
Loss in Banking and Radiation 0·61%
Loss Due to Combustible in Ash 1·4%
Other Losses. Heat in Ash. Moisture in Air Blowdown, etc. 2·95%
Leakage Losses, etc., 2·26%
Loss in Steam Mains 0·83%
Loss in Turbo Windage and Friction 0·93%
Loss in Generators and Exciters 1·15%
Loss in Works Motors and Lighting 0·90%
Loss in Converting Plant 0·15%
To Outgoing Feeders 16·84%
Rejected to Circulating Water via Condensers 54·2%
77·92 + 8·68 = 86·6%
From Condensate 2·07%
From Coolers 1·16%
From Deaerators 3·43%
From Evaporators 0·81%
Returned to Boilers 8·68%
To Steam Auxiliaries 1·09%
Returned via Heaters and Evaps. 0·92%
Used in Auxiliaries 0·17%
Radiated between Turbo S.V. and Heater Outlet via Feed Mains 0·48%
THE ENGINEER

FIG. 31 HEAT BALANCE DIAGRAM

boiler feed pumps, which in turn deliver it to the economisers *viâ* high-pressure feed heaters in which its temperature is raised to 220 deg. Fah.

An open surge tank is connected between the main condenser extraction pump and the de-aerator booster pump. The amount of water which the latter can deliver to the de-aerator is controlled by a float valve according to the requirements of the boilers. Any surplus condensate which the booster pump temporarily cannot take is discharged into the surge tank. On the other hand, when the demand for feed is greater than the condensate available at that time, the pressure on the discharge side of the extraction pump falls and allows the water stored in the surge tank to return to the system, passing to the feed pumps by way of the booster pump and de-aerator. Any failure of the booster pump or de-aerator is provided against by a connection directly from the surge tank to the suction of the boiler feed pumps. A non-return valve prevents the booster pump from delivering water into the surge tank under normal conditions. Should the booster pump fail, thus starving the feed pumps, the drop of pressure allows the non-return valve to open and water can then flow directly from the surge tank to the feed pump suctions. Each main turbine is furnished with extraction and booster pumps in duplicate, one being steam driven and the other motor driven. Make-up water is taken from the town mains and treated either in a lime and soda plant or purified by evaporation. The chemically softened water passes through an independent de-aerator before going to the boilers, while that from the evaporators is either discharged to the surge tank or otherwise mixed with the main condensate, being de-aerated with the latter as described above.

Circulating water is drawn from the Thames through a tunnel 10ft. diameter, which is taken well out into the river, where there is ample water at all times. The tunnel is divided on the horizontal centre line, the bottom part forming the suction and the upper the return. The suction part ends on the land side in an open well 20ft. diameter, which acts as a sump, where the larger and heavier *débris* from the river is retained, to be removed at intervals by grabbing, and where timber and other floating material is arrested by movable screens. From this well a 10ft. diameter tunnel passes under the floor of the pump house and receives the suctions of five centrifugal motor-driven pumps with an aggregate capacity of about eight million gallons per hour. The pumps, which are illustrated in Fig. 34, page 354, are "drowned" except at low water of spring tides. The ends of the suction and discharge pipes are always sealed, so that the only head against which they have normally to work is that due to the friction of the piping and condenser tubes. For removing leaves and other material not arrested in the sump each pump is provided on its discharge side with a rotary strainer, as can be seen in Fig. 34. After passing through this strainer the water is delivered into two 48in. cast iron pipes which take it to the engine-room. It returns from the condensers through two similar pipes which lead it to the top part of the tunnel and so back to the river.

The switchgear at Deptford is arranged in a brick building, 104ft. long by 52ft. wide, built adjacent to the main turbine room. On the top floor are twenty-seven oil switches, each capable of breaking a current of 750,000 kVA. Next to the switch room, but separated by a brick wall, is the control room, illustrated in Fig. 28. This room has windows looking into the turbine room. On the floor below are the duplicate bus-bars. For the interconnection of the 6600-volt and 11,000-volt systems two 7500 kVA banks of single-phase transformers fitted with tertiary windings are provided, the transformers being connected in star-star. The transformers can also be switched on to the single-phase railway bus-bars to enable power for other than railway purposes to be taken from the 11,000-volt generators, two phases of the three-phase windings being used for this purpose. Owing to the capacity of the system when the 6600-volt and 11,000-volt sections are tied together by the transformers, reactor coils have been installed in circuit with the latter and also on several feeders to lessen the shock to the system in the event of a fault occurring.

The modern part of the boiler-house contains twenty boilers providing steam at 325 lb. pressure and at a temperature of 725 deg. Fah. Fourteen of these boilers have each a maximum continuous rating of 65,000 lb. of steam per hour, and the remaining six have a capacity of 80,000 lb. each on the same rating. A view of the firing aisle is given in Fig. 29. As will be seen in the engraving, the coal shoots from the bunkers to the stoker hoppers are duplicated, to enable two different kinds of fuel to be burnt on the "sandwich" system. Thus a low-grade fuel, such as coke breeze, practically unusable by itself, can be burnt in conjunction with coal. To meet the requirements of the railway load a further reconstruction has been commenced. Two sections of the old low-pressure boilers have been dismantled and two new boilers having a maximum continuous rating of 200,000 lb. per hour are being installed in the space rendered available. The removal of a third section of the old plant will provide space for a building to accommodate eight 200,000 lb. boilers and two more large turbo-alternators. The boilers are fitted with compartment type travelling grate stokers arranged for balanced draught, with the exception of three of the 80,000 lb. boilers, which are provided with retort type stokers. The two 200,000 lb. boilers will also have retort stokers and their furnaces will also be completely water-lined.

An interesting feature of the boiler-house is the ash removal plant. The ashes are discharged by a closed shoot from the ash hoppers into a concrete trough in the basement and transported by water sluicing to a sump at the wharf front 350ft. distant, where they can be loaded into barges or wagons by a grab crane. A view of the concrete sluice is shown in Fig. 30. The water is circulated through it by motor-driven centrifugal pumps. The pumps take the water from the ash sump through a metal screen and deliver it to the far end of the trough, whence it runs back to the sump, washing the ashes along with it. The disposal of the riddlings at Deptford is also interesting. They are discharged from the riddlings hoppers under the grates into a system of ducts laid in the basement floor, from which they are blown by air to the top of the bunkers, at a height of 100ft., where they mix with the fresh coal.

Turning now to the performance of the Deptford East station, we give in Table XXII. the heat accounts

TABLE XXII.—*London Power Company, Ltd., Deptford East Generating Station.—Heat Balance for Week Ending May 2nd, 1928.*

	lb.	B.Th.U.
B.Th.U. at inlet to boilers—		
From fuel	6,160,000	69,380,080,000
From feed water	45,018,504	6,122,516,544
		75,502,596,544
B.Th.U. leaving boilers—		
In steam	45,018,504	60,729,961,896
Stack, banking, &c.	—	14,772,634,648
		75,502,596,544
Steam main—		
Main turbines (and de-aerators)	42,651,844	57,281,426,492
Main turbines (and evaporators	400,000	537,200,000
Feed pumps	990,000	1,329,570,000
Soot blowers, glands leakage, &c.	976,660	1,311,654,380
Range loss	—	270,111,024
	45,018,504	60,729,961,896
Main turbines		
Switchboard	—	12,551,553,800
Condensate	—	1,863,885,583
Air extractor coolers	—	810,385,036
De-aerators	—	2,414,094,144
Condenser loss	—	37,742,786,161
Turbine, generator and exciter loss	—	1,898,721,768
		57,281,426,492
Feed pumps—		
Mechanical work and loss	—	240,570,000
Exhaust (to evaporators and heaters)	—	1,089,000,000
		1,329,570,000
Evaporators—		
Mechanical work in turbine		69,200,000
Bled to evaporator		468,000,000
		537,200,000
Returned to boiler—		
Condensate		1,863,885,583
Coolers		810,385,036
De-aerators		2,414,094,144
Feed pump exhaust		1,089,000,000
Evaporators		468,000,000
Town main make-up		28,586,930
		6,673,951,693
Loss in friction, radiation, &c.		551,435,149
		6,122,516,544

Final temperature of feed water = 168 deg. Fah.

of the plant for a typical week. The facts are presented in the form of a balance sheet in Table XXIII. The disposal of the total heat in the fuel is shown in graphic form by the diagram Fig. 31, which represents

TABLE XXIII.—*London Power Company, Ltd., Deptford East Generating Station.—Heat Balance for Week Ending May 2nd, 1928.*

Input.		B.Th.U.
By fuel		69,380,080,000
By feed water		6,122,516,544
		75,502,596,544
Output.	**B.Th.U.**	**B.Th.U.**
Boilers—		
Stack and radiation loss, &c.		14,772,634,648
Steam mains—		
Range loss	270,111,024	
Leakage, soot blowing, glands, blow-off, &c.	1,311,654,380	
		1,581,765,404
Main turbines—		
Output to switchboard	12,551,553,800	
Condensate	1,863,885,583	
Air extractor coolers	810,385,036	
De-aerators	2,414,094,144	
Condenser	37,742,786,161	
Turbine losses, &c.	1,898,721,768	
		57,281,426,492
Feed pumps—		
Friction and work done	240,570,000	
Exhaust	1,089,000,000	
		1,329,570,000
Evaporators—		
Work before bleeding	69,200,000	
Bled to evaporator	468,000,000	
		537,200,000
		75,502,596,544

the average performance during the month of March, 1928. It will be noted that 2·89 per cent. of the heat is returned to the system by the action of the air heaters and a further 8·68 per cent. from various auxiliary plant. Taking account of the latter, 86·6 per cent. of the total heat in the fuel is transmitted to the steam, and 17·0 per cent. goes out of the station in the form of saleable electricity.

Fig. 32 shows graphically the main factors in the efficiency of the plant for the first six months of the year 1928, with the corresponding date for the same

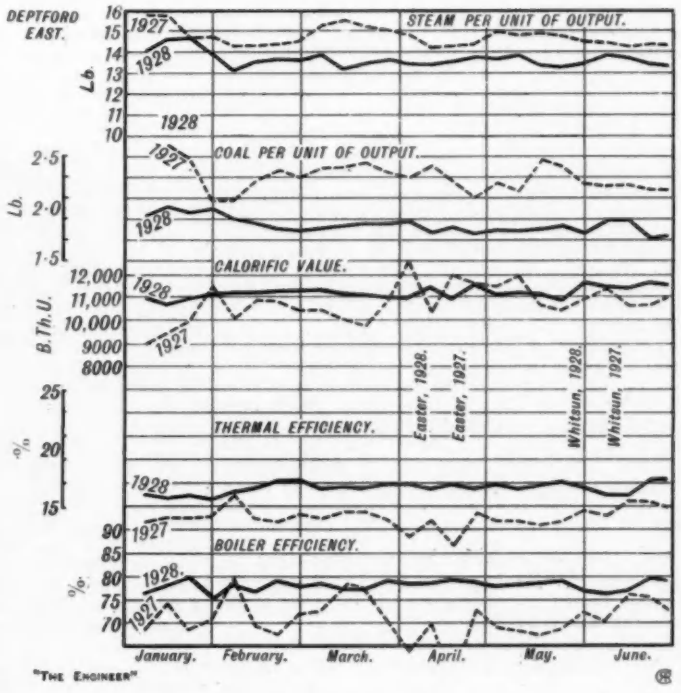


FIG. 32—EFFICIENCY CURVES

period of 1927 added for comparison. A great improvement is obvious. The steam per kilowatt-hour has been reduced by about 1 lb. and the coal per kilowatt-hour, which was over 2·2 lb. for the greater part of the 1927 period, has come down to less than 1·8 lb. The boiler efficiency is much higher and more uniform than in 1927, keeping very near 80 per cent. The diagram shows the station to be doing much better both in boiler-house and turbine room than it was in the preceding year. It may also be confidently stated that its full possibilities have not yet been reached. When the reconstruction work is terminated and the new equipment in regular service, Deptford East will furnish an example of reorganisation as striking almost as the engineering work which made the station famous some forty years ago.

(To be continued.)

The Institute of Metals.

No. III. *(conclusion).**

The morning session on Thursday, March 14th, was devoted to the consideration of three very practical papers. The first of them was by Mr. Harry C. Lancaster, and was entitled "The Importance of Design, and Setting of Large Kettles used for Refining and Low Melting-Point Alloys." In this paper the author deals with some of the problems met with in increasing the size of kettles from 20 tons to 50 tons capacity, and shows how the larger units require radical alteration in design to be successful in practice. It is also demonstrated that close attention to details has given increased life to the kettles themselves, with consequent reduction in the cost of the metal treated.

Kettles for Alloys.

The President congratulated the Institute on the presentation of so practical a paper. It was very often, he said, the amount of attention devoted to the minor points which made all the difference between success or failure in industrial processes, and the discussion of facts and problems of the kind Mr. Lancaster had put forward was valuable.

Mr. D. F. Campbell asked for information as to the cost of replacement of kettles, and the cost of heating by different means. Quite recently he had had to consider the problem in connection with a works in Algiers, at which cables were to be manufactured, and in connection with another works in France. The kettles to be used were very much smaller than those referred to by Mr. Lancaster, but he was considering the heating of them by electricity. In that case, the temperature of the source of heat was very much lower than flame temperature, and in consequence there was less stress on the metal than when a flame was used. He asked Mr. Lancaster if there were any possibility of the adoption of electric heating, in spite of the higher cost, bearing in mind that with electricity one could secure even heating, and that the temperature of the source of heat was probably about 1000 deg. as a maximum, whereas flame temperatures were very much higher. Further, the electrical method lent itself very well to the supporting of the pots, and one could absolutely control the temperature—which was very important in the application of lead to cables.

Mr. A. H. Mundey, speaking as a user of kettles of capacities ranging from 3 cwt. to 15 tons, said that his company had tried many sources of heating, and had very largely, though not entirely, abandoned the use of solid fuel, mostly on account of lack of space, and of convenience and cleanliness generally in the works. Gas, oil and in some cases electric heating had been adopted, and the use of those fuels introduced fresh sets of problems. With gas heating, and with oil heating particularly, local hot spots were apt to occur, and, owing to the inrush of cold air from the opening or any other untoward cause, kettles were apt to crack. His chief trouble was the development of spongy spots which allowed the metal to weep through after the kettles had been in use for some time, so that it was quite evident that changes occurred in the cast iron. He had tried to prepare specifications for cast iron but it was very difficult to make certain of getting deliveries of perfectly uniform castings, because, after one had standardised the iron one needed to be able to give immense orders to enable the suppliers to guarantee to supply standardised cast iron for particular services such as that. The grave difficulties that occurred when a pot failed could hardly be imagined; if a big pot leaked badly, the stokehole might become full of molten metal, which solidified. Some time ago he had been asked to go to a newspaper office in great haste to deal with a difficulty of that sort. Stereotype pots were of very queer shape; in many cases they could not be designed particularly for endurance, but must be designed to suit the purpose of the machines to which they were attached. On arrival at the newspaper office in question he had found the stokehole nearly full of metal, partly solidified and partly molten, and the metal was still coming through. It had to be cleared, however, in order that the night edition of the paper could be printed, and a new pot had to be installed. The particular pot which had failed had been running for fifteen years, during which period it had been heated every night, and yet a huge crack had developed across it suddenly. The trouble could not have been due to bad design or to defective metal.

The President, commenting upon Mr. Campbell's proposal to heat the kettles by electricity, suggested that electrical immersion heaters might be used. The temperatures involved were not very high, and it would not be difficult to construct a heater which could be immersed in the molten metal so that the whole of the heat would be generated within the metal and would not have to pass through the pots. It appeared that that would considerably relieve the duty to which the pots were exposed. It was interesting to note that a cast iron pot, heated to temperatures of about 800 deg. Cent. and cooled again from time to time would stand up to the work for such long periods as had been mentioned. With regard to the experience mentioned by Mr. Mundey, in which a pot in a newspaper office had failed, he said that those responsible had only themselves to blame if they did not replace a fifteen-year-old pot immediately it was found to be weeping. The tendency to carry on too long was a real danger. The sinking of a pot, and particularly the local bulging, were curious phenomena in a material such as cast iron, which was non-plastic. Whether the trouble was connected with the growth of cast iron, or whether it was due to plastic deformation at the high temperatures attained, was quite an open question; if the cause could be found out it might be possible easily to improve the cast iron to resist that action. Heat-resisting cast irons had been developed to a very great extent during recent years, and he was sorry to hear Mr. Mundey suggest that it was necessary to give immense orders in order to obtain standardised cast iron products. If that were so, it was a very serious indictment of the iron founders, and it should be put to them that a product of this kind ought to be available.

Mr. Mundey said that the immersion heater principle was adopted to a quite considerable extent in the trade in which he was interested.

Professor C. H. Desch was of opinion that the bulging of the vessels was due to growth and not to plastic flow. He had had experience of large kettles used for caramelising sugar and holding a ton or two of the material, and they certainly had shown that kind of growth, although the temperature to which they were subjected was only 200 deg. Cent. or a little more.

Mr. Lancaster, replying to the discussion, said that he had had no practical experience of the heating of lead by electricity. Experiments had been carried out at his works in the direction of the heating of lead by gas, not by heating underneath the pot, but by means of the Bone-Court system, *i.e.*, by conducting the heat directly into the metal itself through wrought iron piping. Those experiments indicated, however, that it would not be successful commercially. He hastened to explain that he was not condemning the Bone-Court system; it was conceivable that that system might be employed with advantage, but in the particular experiments referred to it did not appear to be an improvement over the use of solid fuel. It was impossible to indicate the cost of replacement or the cost of heating lead unless one had details of the circumstances. Many people were apt to forget the banking charges over the week ends, the cooling operations, the drawing of ashes, and so on, which were all factors of cost. He believed that electricity could be used for melting lead, but it all depended upon cost. Although he believed the cable companies were very prosperous and could afford to do things which other people could not do, all keen men were out to melt at the lowest possible cost.

Commenting on Mr. Mundey's reference to spongy pots, he said that, with one or two exceptions, such as when the castings had been made by inexperienced people who had thought they could make them cheaper, he had never had a really spongy casting during his experience of forty years. People who understood the work were able to make exceedingly fine castings. Finally, in an appeal to manufacturers to give practical information, he said that they could help one another without giving too much away.

The next paper was by Dr. Rosenhain and Mr. Prytherch, on "An Improved Form of Electric Resistance Furnace." The gist of it is given in the following abstract:—

AN ELECTRIC RESISTANCE FURNACE.

An electric resistance furnace is described for which advantages are claimed in regard to higher available working temperatures—up to 1400 deg. Cent.—durability, and freedom from oxidation of the carbon resistor. The heating element of this type of furnace consists of carbon or graphite pellets, or short rods placed end to end in a refractory sheathing tube, which fits easily over them. Heating occurs by contact resistance. The sheathing tube prevents the access of air sufficiently to avoid any appreciable burning of the carbon.

Dr. Max Haas, after emphasising the need for a laboratory furnace for use at high temperatures, asked if it were possible to use a furnace of 5, 8 or 10 cm. diameter, of the type mentioned by the authors, for the purpose of heating a crucible to 1500 deg. He also asked what was the nature of the ceramic material used to enclose the carbon rods.

Mr. A. Glynne Lobley, referring to the authors' statement that no actual measurements of change of resistance with time had been carried out—up to the time the paper was written—asked if figures had since been obtained. The matter was of extreme importance, because, if there were changes of resistance in one part, as distinct from another, hot spots would occur. He also asked for information as to the nature of the refractory tube, and whether chemical action had been found to occur between the carbon in the carbide form and the refractory.

Mr. A. B. Winterbottom said that his firm had been interested in the carbon contact resistance when Dr. Rosenhain had first described it. It made an electric fire with a carborundum glow bar in a parabolic reflector, and wanting something with a longer life, it was attracted by the possibilities of making a variable load heater. It had constructed some heaters on the same principle, using, in the first place, vitreosil tubes with small carbon pellets 1/32in. long and of about ⅛in. diameter. With 400 of those pellets in a tube it had got about 100 volts across without too high a current, and had got it when operating at temperatures from 900 to 1200 deg. He asked if the authors could give data as to the best voltage per contact to use and the approximate density. Further, he asked if they had had experience of different qualities of carbon. In the first apparatus he had made he had used a sort of arc carbon, and it had stuck together for some time. Afterwards he had used a plain carbon, and it had not appeared to suffer any change at all.

Mr. W. B. Clarke referred to some granular carbon resistance furnaces with which he had been concerned, and which reached extremely high temperatures, and said that he gathered that the furnace described by the authors was not intended to reach extreme temperatures. He asked them what was the difference as between alternating and direct current in its effect on the resistance of the pellets in their furnace. He imagined there would be a considerable difference between the two in that respect.

The President replied to the discussion. With regard to Mr. Clarke's remark that the furnace was not intended to reach the extreme temperatures which could be obtained in electric carbon resistance furnaces, he said that there were two other requirements for that. One was permanence of the resister material, and the second was the absence of, at any rate, anything more than traces of carbon bearing gases in the furnace atmosphere. One of the fundamental differences between a furnace of that type and the granular carbon resistance furnace was that the resister in the former was, relatively speaking, permanent—and in that connection he spoke conservatively, because the authors had not yet discovered the length of run of which one of these resistances was capable. Oxidation was so slow that after hundreds of hours' running at temperatures round about 1300 deg. Cent. one could see no appreciable effect upon the appearance of the pellets when they were removed from the carbon sheath. The reason was interesting. It was not necessary to attempt to make the sheath gas-tight or to have any gas-tight fitting between the resister and the sheath. There was a capillary air space to begin with, and later on a space filled with gases in equilibrium with the hot carbon, and that was quite sufficient to act as a protection from the external atmosphere. The viscosity of carbon dioxide, particularly at high temperature, was very high and the rate of diffusion was, therefore, quite slow. The consequence was that the capillary space acted as a perfectly satisfactory seal for that purpose, and left the resister pellets and electrodes at the ends free to move and maintain contact. The authors would not attempt, and did not recommend, any method of varying the pressure for regulating the temperature of such a furnace. Any attempt to regulate by that means resulted, in his experience, in irregularity. One could increase the pressure, but could not decrease it again uniformly throughout the column, and there resulted uneven contact pressures and hot spots. They worked with a constant pressure. He ventured to say that the limit of time or temperature at which the furnace could be used depended upon the refractory material of which the sheath was made. The authors had used the German product, Pythagoras porcelain, which was very satisfactory up to a certain point, but it would certainly not withstand temperatures as high as 1500 deg. It would, however, stand temperature of from 13,000 deg. to 14,000 deg. for a long time, provided it was well supported; but he considered 1400 deg. was quite the upper limit. On the other hand, it was not impossible to make special refractories which would stand much higher temperatures for the purpose, and some of his colleagues were engaged on that work; but he did not think that temperatures of about 1800 deg. Cent. could as yet be exceeded at reasonable cost. At the moment that temperature had not been reached.

He could not give data as to the change of resistance with time, but might be able to do so when the discussion was printed in the Institute's "Proceedings." The furnaces ran so steadily that actual measurements of the resistance had not been made. For similar reasons he was unable to answer Mr. Winterbottom's question as to the desirable voltage per junction.

The next paper presented was one by Mr. D. F. Campbell, on "Recent Developments in Electric Furnaces." Below is the official abstract of it:—

ELECTRIC FURNACES.

The paper describes the improvements and modifications in melting practice during the last two years, and discusses the relative performance of small and large induction furnaces, and the reasons for selecting the size of unit according to the

* No. II. appeared March 22nd.

work to be done. A short description of improvements in practice with high-frequency furnaces and details of new methods of lining these furnaces are given. A general survey of heat treatment furnaces follows, with a detailed description of the construction and performance of a number of specific furnaces, including a continuous furnace for annealing brass strip. The largest brass works where electricity is utilised more than elsewhere, is described, with explanation of the uses to which electricity has been applied, with diagrams showing the energy consumed and the effect of the special precautions used to improve power and load factor.

Mr. A. Glynne Lobley, referring to the author's statement that the measurement of the consumption of energy to maintain the required heat with doors closed, or the rate of temperature drop after the current was cut off, were simple and effective methods of indicating thermal efficiency, said that the first method was a good one, but that the determination of the consumption was by no means simple. As to the rate of cooling, he pointed out that it depended not only on the insulation, but on the heat capacity of the inside of the furnace, so that a furnace which was heavily constructed inside would cool at a slower rate than one less heavily constructed. Therefore, the cooling curve method should not be adopted normally, and if it were adopted it should be considered with great care. The problem of determining the heat loss of a furnace was a difficult one. It was often imagined that if one stopped using the furnace for some time and then turned on the energy required to maintain the temperature, one could arrive at the heat loss. The problem was not so simple as that, however, because a considerable time elapsed before the materials reached equilibrium and before the temperature gradient became constant from the inside to the outside of the furnace. As an example of the difficulty of measuring heat loss, he mentioned an attempt to determine it in respect of a furnace which was operating normally at about 900 deg. At the end of a day's work the furnace was left with the current switched on for a couple of hours, and the consumption measured during the second hour. The loss indicated was just under 7 units. That figure was thought to be unduly low for such a furnace, which had a usable inside length of 7ft. and a width of 3ft. 6in. On investigating what had happened during the day it was found that for a short time the furnace had been used at a temperature of about 950 deg., which was a little higher than the normal, and it was thought that, probably, a surplus of heat in the lining was responsible for reducing the heat loss figure. Another determination was therefore made in a similar way and a figure of 14 units was obtained. The furnace was then left empty for twelve hours, with the energy on, and at the end of that time a determination was made. It was then left for another two hours, when a further determination was made, and the results of these two determinations were the same, the figure being 8·3 units. He suggested that a useful figure to specify would be the consumption in units per ton of output of material.

The decision as to whether or not an electric furnace should be installed usually depended, ultimately, upon cost. The direct fuel costs in respect of an electric furnace were not always less than the fuel costs in respect of other types of furnace, but they were sometimes, and in a very great number of cases the electric furnace certainly had an advantage in overall cost. As an example he mentioned a case in which it was proposed to install an electric furnace for heating steel plates for straightening and bending. The operation could be carried out more cheaply with a coke furnace, from the point of view of fuel costs, but the electric furnace had several economic advantages. One was the fact that it could be placed just where the process was being carried out; and it happened to be a position in which it was impossible to place a solid fuel-fired furnace. Again, being automatically controlled, it required no attention, the working temperature could be attained before the shift started, and the product was cleaner. The electric furnace was, therefore, installed, and it was found that the direct labour cost in connection with the handling of the plates was reduced by an amount equivalent to the whole of the electricity bill.

With regard to carburising furnaces, Mr. Glynne Lobley gave figures relating to the operation of a modern electric furnace as compared with a modern recuperative gas furnace, giving the costs over a whole week, the furnaces being worked night and day from Sunday night until Saturday mid-day, so that the cost of heating up was included. The electric furnace had a usable hearth of 6ft. 3in. by 3ft. 9in., and the gas furnace, although it measured a little more, was not able to take quite so big a charge as the electric one. They were both loaded to the same extent, the carburising periods ranging from eight to twelve hours. The average consumption of the electric furnace was 20 units per hour, which worked out, with the price of current ruling in the district, at 12·3d.; the cost of working the gas furnace worked out at 18d. per hour, with cheap gas at 2s. per thousand cubic feet. The cost of running the gas furnace, when it was first tested, was 2s. 6d. per hour, but by altering dampers and generally tuning up the furnace the figure was reduced to 1s. 6d. per hour. A new type of furnace in this country was the rotary annular hearth furnace for the heat treatment of gears. The design was entirely British and did not follow American lines. Accurate consumption figures were not yet available, but preliminary observations had shown that the consumption was about 250 units per ton, and it was doing what was expected of it. Very great improvement in the product, because of even and uniform heating, which had eliminated distortion, was effected.

Dr. H. W. Brownsdon said that, from the electrical point of view, electric furnaces were fairly efficient, but we were still confronted by problems with regard to refractories from the economic point of view. The Wyatt and Northrup types of furnace depended for their economic running upon the life of their refractory linings. There was no doubt that in both those types melting could be carried out more cheaply than in furnaces using gas or other types of fuel, provided the linings had a certain minimum life; the linings must have very special properties. He had used a Wyatt furnace lined with Sillimanite. As a refractory it was excellent, but, after melting quite a big tonnage of brass, the furnace had failed because the Sillimanite lining had allowed zinc to diffuse through it—99·5 per cent. pure zinc had diffused through a 1½in. or 2in. thickness of refractory—and short-circuited the electrical equipment on the other side. That pointed to the fact that these refractories must sinter or fuse superficially to prevent the diffusion of zinc vapour through them. A big advance effected quite recently in the Northrup furnace was the adoption of the sintered lining. In that case, however, there was a compromise, because the lining fused to a kind of glass, the coefficient of expansion and contraction of which was rather high, he imagined, so that it was somewhat liable to damage. It was also of considerable thickness, so that it prevented close coupling and the electrical efficiency of the furnace was probably somewhat reduced in consequence. There was far too much agitation in the Ajax-Northrup furnace. That might be useful in certain refining operations, but for the simple melting of metals it would be generally advantageous to have a more quiescent melt, especially in certain cases in which the metals were reactive with air. A weak point of electric furnaces was that the temperature gradients were big. In the Wyatt furnace the heat was generated in a very small area, and in the other type there was a tendency to heat-concentrations. There was no doubt that there were hot spots where, probably, reactions could take place between graphite and silica, and so on. Was it not possible to arrange for the heat to be more evenly and uniformly absorbed by the metal, rather than to effect the solution of cold metal in what one might consider to be a superheated metal? With regard to the annealing furnace, he suggested that it would be advisable to couple it with the pickling and cleaning furnaces. The one winding mechanism would then take the metal through the muffle, remove the oxide film, and leave a uniformly annealed and clean product.

Dr. R. S. Hutton (Director, British Non-Ferrous Metals Research Association), who had visited the works of the Hirsch, Kupfer u. Messingwerke, A.G., near Eberswalde, Germany, said that Mr. Campbell's statement with regard to those works was exceedingly conservative. His own impression was that the replacement of electric for fuel heating had been carried a good deal further than was indicated by Mr. Campbell. Indeed, he had been so surprised by the development there that he had asked the young director who had accompanied him during his inspection how the elderly directors had been persuaded to scrap the old plant and install the new. The reply was that there were no elderly directors, and that the oldest one was only forty-five years old. In other words, the directors had been scrapped first and the plant afterwards. An outstanding point was the improvement which had taken place in the lining of furnaces.

Mr. W. R. Barclay, speaking as one particularly interested in furnaces capable of dealing with high melting point alloys, said that he retained his great admiration for the arc furnace for that purpose. He had also had experience of the high-frequency furnace, and could bear testimony to some of its advantages, but felt that we had still a long way to go before we could fathom all the factors bearing upon its success. One of the difficulties was found in connection with refractory linings, and although important advances had been made recently we were still by no means out of the wood. By careful work one could build a hearth for the arc furnace, say, with magnesite bricks lined with a high-grade magnesite powder, thoroughly well rammed and properly treated in its early stages, and he had still at work furnace linings which had been used for twelve months in arc furnaces dealing with pure nickel and high-nickel alloys. In view of the difficulties with refractories the high-frequency melting proposition hardly compared with that of melting in arc furnaces. He urged the need for a much more detailed study of the subtle differences in the action of the product of the high-frequency furnace and of the arc furnace. There was also difficulty in getting absolutely clean metal from the high-frequency furnace. Reference had been made to the extreme agitation, and it was obvious that with an acid lining there would be produced a considerable amount of slag. As a rule one could get rather cleaner metal from the arc furnace than from the high-frequency furnace. The problem of deciding upon the economic unit for melting had still to be settled, and he was glad to note that the range of units had extended so enormously during the last year or two. Whereas two or three years ago buyers were asked to accept high-frequency furnaces of only 10 lb. or 20 lb. capacity, Mr. Campbell was now offering furnaces of 1-ton capacity, and that represented one of the greatest advances in connection with the high-frequency furnace.

Mr. T. H. Turner asked for Mr. Campbell's comments upon two industrial electric heat treatment furnaces used abroad. One was the inverted box type, which was raised or lowered on to the work and required flexible connections or connections which must be broken. The other was a furnace, somewhat of that kind, perched in the air, giving black body conditions, and enabling one to overcome dangers of convection currents causing variations. It was employed on a large industrial scale in America, and when used for sheets or plates of relatively small dimensions or irregular sizes, the metal was charged on to a bogie and run under the furnace and raised on the bogie into the furnace. So far as the treatment of the material was concerned, it was obvious that little or no oxidation should occur Neither of these types of furnace was used in this country so far as he was aware.

Mr. W. B. Clarke, referring to the linings used when dealing with high melting point alloys, said that the lives of the crucibles were invariably very short. He had had them lined with the usual linings, but they did not appear to prolong the life of the crucibles. They were then painted inside and out with the very best fire-clay procurable, but that seemed to have little effect. Eventually, however, it was found that the lives of crucibles and furnace linings were increased to a wonderful extent by painting them with a water emulsion of osmos clay—a very pure form of clay. Comparing the arc furnace with the induction furnace, Mr. Clarke said that one must consider the certainty of getting carbon in from the arc, and if one wanted to keep carbon out it would appear that the high-frequency furnace had the advantage. Emphasising the importance of close control of temperature in continuous processes, he pointed out that the ability to control the temperature was a great advantage of the electric furnace. He was using electric furnaces of the tubular form at temperatures ranging from just over 100 deg. to 1500 deg. or 1600 deg., and could control the temperature very well over that range by using a voltmeter. When gas furnaces were used, temperature control was difficult, owing to the variation of the pressure and the calorific value of the gas. A variation of 1 or 2 volts in an electric furnace would not make anything like as much difference as would a difference of one or two-tenths in the pressure of the gas supplied to a gas furnace.

Mr. S. L. Archbutt asked for further details of the new method of lining the container of the Ajax-Northrup high-frequency induction furnace. It was stated in the paper that the method consisted of forming a furnace lining by placing a metallic liner or template inside the furnace and pouring a carefully prepared lining material between that liner and the furnace inductor coil; he could not see what prevented the refractory material running into the inductor coil. It had been stated by the author that the cost of the electric furnace was, generally speaking, high, but his figures with regard to two heat treatment furnaces in the Midlands showed that the cost of their operation compared favourably with that of gas furnaces.

Mr. Campbell, intervening, said that he had meant that the cost of installation was high, but not the cost of operation.

Mr. Archbutt, continuing, said that he believed that a lot of failures with gas furnaces in the past had been due to the inability to control the temperature. With regard to the Snead annealing process, he asked how it was proposed to get rid of the cold ends of the rods or tubes, because the ends, which were held by the clamps, must be cold. Finally, he asked what were the possibilities of the development of induction heating for heat treatment and preheating purposes.

Mr. F. Adcock, discussing nomenclature, suggested that the term "high frequency" was often misapplied. At the beginning of electric furnace development, frequencies were high, but to-day there were furnaces running at 50 cycles, which could not be called high frequency. He suggested that the term "ironless" or "coreless" should be applied to induction furnaces. Mr. Adcock also asked how small adjustments were made in the generator plant for tuning. He gathered that it was necessary to change the frequency with the load.

The President, dealing with the problem of agitation in electric furnaces, said that it was very important. In steel making the agitation had an immense effect in producing a very rapid attainment of equilibrium between slag and metal. There was the countervailing disadvantage, however, that any particles of slag, lining or any other non-metallic substance, when once entrained in the metal, had not the opportunity of rising to the surface, as it would in quiescent crucible melting. The only cure that he could think of—short of frequency adjustment, which had electrical disadvantages—would be to switch off the current for a sufficiently long period to allow the metal to come to rest and to allow, at any rate, the larger impurities to rise to the surface. Unfortunately, however, the rate of cooling when the current was off was extremely rapid, in view of the thin lining. With regard to the comparison between the arc

furnace and the coreless induction furnace, he pointed out that the latter offered the possibility of controlling the gaseous atmosphere to which the metal was exposed during the whole process of melting and casting. The induction type of furnace permitted of melting in vacuo, and he habitually melted alloys of high melting point in vacuo. The arc type did not permit of that, and the advantage of the induction type in that respect was likely to prove an important factor. It might be thought that melting in a controlled atmosphere was a laboratory rather than an industrial process, but the work of Dr. Rohn in Germany showed that it was an industrial process, and it was likely to be used more extensively in industry in the future. As to the suggestion that the products of the arc furnace and of the induction furnace should be examined to ascertain what were the slight differences in their characteristics, he suggested that those differences were due more to exposure to or protection from the gases than to the other factors in respect of which the furnaces differed.

Mr. Campbell replied to the discussion. Dealing with Dr. Brownsdon's reference to the agitation of the metal in the Ajax-Northrup furnace, he said that that matter had been thoroughly studied and was thoroughly understood. In certain operations, with some alloys, considerable agitation was necessary. He mentioned the mixing of tungsten—which had a very high specific gravity—with steel, and said that absolute homogeneity was attained in that case; there must be sufficient motion to mix the tungsten with the steel but not sufficient to remove the slag and expose the steel to oxidation. The movement of the metal could be varied by varying the periodicity and the dimensions of the furnace, and so on. He had had a good deal of experience with Sillimanite as a refractory, and it seemed that there might be some chance of making Sillimanite linings impervious to zinc fumes which were metallic and caused short-circuiting. With regard to the comparisons of the arc furnace and the high frequency furnace, and the references to the great difference between basic and acid working, he said that in many cases the high-frequency furnace with an acid lining with a sticky slag and under acid conditions had been compared with a basic furnace with magnesite lining and basic slag, which was almost all lime but contained a little fluorspar, and which had quite different characteristics; it was not sticky. The high-frequency furnace could be worked with a basic lining. If one compared arc furnace and high-frequency furnace results, one should be careful to compare acid with acid and basic with basic, or allow fully for the great difference in the characteristics of the two. There were arc furnaces working on acid linings and high-frequency furnaces working on basic linings. As to the necessity for continuous working, he suggested that, inasmuch as the body of the high-frequency furnace was so simple, it was useful to keep spare bodies in stock and replace the old ones when necessary. It was the practice in many works to allow the metal to rest in the high-frequency furnace. It might pay, as Dr. Brownsdon had suggested, when continuous annealing was being carried out, to have the pickling machine in a straight line with the annealing furnace and use the same gear for the two operations. It must be remembered, however, that the pickling machine could work three times as fast and deal with three times as much material as could the annealing furnace.

The inverted box type of resistance furnace, mentioned by Mr. Turner, was used in France for annealing copper and aluminium wire, and was quite generally known as a type of furnace which was rather expensive to install as compared with others, but it was efficient. He asked if Dr. Rohn (of Germany), who was attending the meeting, would contribute to the Institute's "Proceedings" a description of the inverted type of furnace with the water seal, which he used for annealing, and some particulars of his experience with the working of various types of linings in high-frequency furnaces. In this country we were deficient in the type of furnace which was water sealed for annealing in special gases. Mr. Campbell agreed with Mr. Archbutt that the ends of the tubes or rods annealed in the Snead annealing machine had to be cut off, and that was one of the disadvantages of the machine, though the amount could be reduced to very small dimensions. Advances were being made in the direction of using the induction furnace for heat treatment, but he could not say that at the moment there was any substantial industrial application of it in that respect. Possibly it might be used to a very large extent for the heat treatment of mining drill steel, but there were many complications with regard to the mining regulations which were not yet settled and the economic factor had not been determined.

As to nomenclature, Mr. Campbell said that for the last eighteen months the word "ironless" had been applied to the induction furnaces, and they were subdivided into the high-frequency and the normal fre-frequency furnaces. Formerly the expressions "medium" and "high" frequency were used, but it was decided to use the term "high frequency" for all frequencies above normal frequency, and to apply the term "normal frequency" to furnaces which could be connected directly to the towns' supplies. There was no motor, of course, with the normal frequency furnace.

Replying to Mr. Adcock's question as to tuning with big motor generator sets, he said that the big sets were worked at constant periodicity. The limiting factor at present in the induction furnace was the difficulty of obtaining silica ware in sufficiently large sizes for very large melts.

The proceedings on Thursday afternoon, March 14th, lasted only a little over an hour, although four papers were presented. The first was one on "Alloys of Zirconium: II.," by Mr. C. Sykes, in which, in the absence of the author, was presented by Professor C. H. Desch.

ALLOYS OF ZIRCONIUM.

Measurements of certain electrical and magnetic properties of copper-zirconium, iron-zirconium, and nickel-zirconium alloys are given. These show that the addition of zirconium leads to no material improvement in the properties of the metals, and in certain cases is detrimental.

Two further partial series of binary alloys are described, viz., aluminium-zirconium and silver-zirconium. The systems exhibit little solubility in the solid state at room temperatures and intermetallic compounds are formed. In the low-percentage alloys, viz., 10 per cent., the compounds crystallise in the form of long, fine needles, and consequently the structure of the alloys is very coarse. Hardness figures for aluminium and silver-zirconium alloys are given, together with measurements of tensile strength, ductility, corrodibility, and resistivity of the aluminium alloys.

Dr. Max Haas inquired if the author had taken any equilibrium diagrams.

The President suggested that these researches on zirconium alloys could only be regarded as a very rough preliminary exploration. He did not think that they pretended to more than that. The experimental difficulties were very great, and he was afraid they had not been faced by the author; indeed, they had been avoided and left alone. For instance, he did not imagine that great precautions had been taken to ascertain whether the material used was pure zirconium or a mixture of zirconium and hafnium. The two materials were closely associated from the alloying point of view, but they might not be interchangeable. A most serious difficulty was the exclusion of nitrogen, which was fatal to zirconium compounds and might readily affect the micro-structure of some of these alloys. Some of his colleagues had spent more than two years working upon the effect of nitrogen on iron-chromium alloys, and the effect was found to be so great that it completely masked the whole structure of the iron-chromium system and led to completely erroneous results. Caution must, therefore, be exercised in interpreting micro-structures, particularly when unaccompanied either by thermal data or even measurement of electrical resistance or other properties under variation of temperature. The author had, wisely, made no attempt to establish an equilibrium diagram; but, nevertheless, even such information as the paper contained was worth having.

Dr. Desch said that the determination of an equilibrium diagram was going on at the present time. With the type of furnace used it was not possible to keep the temperature constant for sufficient time, or to arrange for a sufficiently slow rate of cooling to make thermal curves which would have been of any use. That work, however, was being done with a different type of furnace. The high-frequency induction furnace in the form in which it was originally used did not lend itself to that class of work; but now that materials, gas-tight at high temperature, could be obtained, a new furnace had been constructed, and by its aid it was proposed to construct thermal diagrams. He agreed that the zirconium was not quite free from hafnium, but the point had not been lost sight of. The work was merely a preliminary, as a matter of fact, to a hafnium research. Special precautions were taken to exclude nitrogen, and that was the reason for doing the whole of the work in an X-ray vacuum. From the point of view of nitrogen, the zirconium was of a high degree of purity; there was a small quantity of oxygen which could never be eliminated, but, in spite of that, the material was very ductile and could easily be bent between the fingers. The hafnium had not been removed by fractionation, however, but the points which crystallised out were definite points and were not due to any exceptional impurity.

The President said that it was evident that his remarks as to nitrogen had been based upon a misunderstanding; he did not realise the precautions that had been taken to avoid nitrogen.

The next paper was "The Resistance of Zinc to Indentation," by Dr. J. Newton Friend and Mr. W. E. Thorneycroft, the latter submitting the paper, of which the following is an abstract, in the absence of Dr. Newton Friend.

THE RESISTANCE OF ZINC TO INDENTATION.

A machine is described for determining the rate of indentation of zinc by a steel conical die acting under small gravity loads. For the range of loads employed the relation at constant temperature between depth of indentation D, applied load L, and duration θ, of application of load is given approximately by

$$D = a\, L^p\, \theta^m,$$

where a is the depth of indentation produced by a load of 1 kilos. acting for 1 second, and p is a constant. The nature of m requires further investigation. The a-temperature curve shows a change in direction at 160 deg. to 170 deg. Cent., which is significant, in view of the supposed allotropy of zinc in this region.

This paper was followed by another paper by Dr. Friend alone, entitled "The Solution of Plain and Amalgamated Zincs in Electric Batteries," which was taken as read; and the final paper was by Dr. Newton Friend and Mr. Thorneycroft, on "The Silver Contents of Specimens of Ancient and Mediæval Lead."

The President said that although the matter discussed in this paper was almost purely of archæological interest, the study of the ancient metals of all kinds had not been carried nearly as far as it deserved. Very little indeed was known of the history of ancient metals, but it was of very considerable interest to try and realise the conditions under which such metals were produced in ancient times. There was, indeed, a practical side to the matter. Certain engineers at the present time were raising the question whether heat-treated aluminium alloys were sufficiently permanent to be used for structures which were intended to be enduring. It was suggested that those materials were in an unstable condition and tended to revert to a weaker and softer state. That did not refer to corrosion, but merely to possible changes in the materials owing to instability. The only really sound answer that could be given must come from the purely archæological study of ancient metals, such as the authors and others were carrying out. For instance, Professor Honda, of Japan, had studied ancient Japanese swords, some of them thousands of years old, and had shown that they had definitely retained their full hardness. They were as hard as they could be made to-day, and he felt that that served as a very fine answer to the alleged instability of heat-treated and hardened and tempered steels. Therefore, such investigations should be encouraged in such a way that our knowledge of ancient metals and metallurgy should become much more complete than it is.

In proposing a vote of thanks to the Institution of Mechanical Engineers for allowing the Institute the use of its rooms once more for the purpose of the meeting, the President referred to the hope that, in the not too distant future, certain of the metallurgical societies might be able, by combination, to secure a building of their own so that it would not be necessary for the Institute to be dependent permanently upon the Institution of Mechanical Engineers for the hospitality which was always so generously given. That, however, was a plan for the future, and in the meantime the Council and members of the Institute of Metals were very greatly indebted indeed to the Council of the Institution.

Professor F. C. Thompson seconded the vote of thanks, which was carried with acclamation, and the meeting closed with a reminder from the President of the May lecture by Sir Oliver Lodge, F.R.S., who, however, had not yet decided the title of it.

Regenerative Surface Condensers.

By THOMAS PETTY.

No. IV.*

(10) Principles and Limitations of Regenerative Design.

The principles and limitations of regenerative condenser design may now be considered briefly in the light of the discussions of the previous sections.

As a first requirement, any condenser, whether of regenerative type or otherwise, which is to yield condensate of a consistently high temperature under conditions of normal air leakage, must be provided with a devaporiser of ample capacity. Where it is an integral part of the main condenser, the devaporiser should be arranged or sheltered in such a manner that the condensate, or, at any rate, the major part of it, does not flow, on its way to the condensate outlet, over surface engaged in air concentration. With this end in view, the surface specifically set apart to form the secondary section should not only be sufficient in extent, but means should be employed to secure a uniform passage over it of the residual mixture to be devaporised, and thus to avoid the extensions beyond the sheltered zone which arise from localised suction effects. Condensate deposited in the devaporiser is usually cooled to a relatively low temperature, but, owing to the small quantity involved, produces only a negligible effect on eventual admixture with the main body of the condensate. Thus in the case of Fig. 1, *ante*, only 1·3735 per cent. of the total steam remains to be condensed after the temperature of the mixture has fallen 0·5 deg. Fah.

In proceeding to consider the principles which should regulate design in the primary section, it is convenient to commence by an examination of the characteristics of an ordinary design of condenser, with closed tube bank, as shown very diagrammatically in Fig. 14. The primary section is arranged to carry out fully the counterflow principle, the air-steam mixture of decreasing temperature and increasing air richness passing downwards through a deep tube bank as continuous as is consistent with the necessary transverse division between the passes, while the circulating water enters the condenser at the lower and leaves at the higher pass. The wedge-shaped form indicated is one which has been adopted frequently with a view to maintaining the velocity of steam flow as uniform as possible, approximately similar conditions obtaining in tube banks of modified cross section adapted for accommodation in cylindrical or bowl-shaped shells. It is obvious that such

* No. III. appeared March 22nd.

arrangements, while favourable from the velocity point of view to the promotion of high heat transmission efficiency and the avoidance of air blanketing, preclude or considerably minimise the possibility of regenerative effects arising from velocity changes in the tube bank itself, and increase the hydrodynamical resistance therein. As will be seen, the condensate, in addition to traversing any secondary surface which, owing to the conditions of operation, may extend beyond the sheltered devaporiser, is collected and withdrawn below the exit from the main tube bank and adjacent to the entrance to the devaporiser. It therefore runs the risk of being cooled by direct transmission of heat at surface engaged in air concentration, and in any

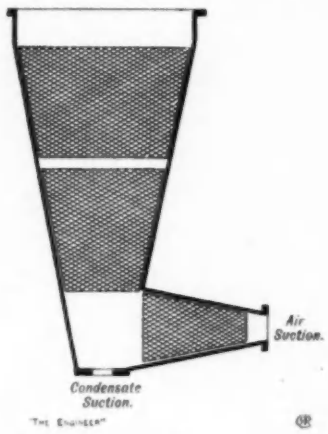


FIG. 14

case must fall to a state of thermal equilibrium with the reduced vapour pressure arising from resistance due to the deep tube bank and maintained velocity, and the preliminary air concentration occurring before inlet to the devaporiser proper.

As a partial and obvious step towards remedying these defects and one frequently employed in regenerative design the closed form of tube bank may be abandoned for an open one, through or round which passages are formed for the conveyance of inlet steam having a relatively high partial vapour pressure and negligible partial air pressure, direct to the collecting area for the condensate. Sketch designs for such arrangements are given in Figs. 15, 16 and 17. Passages so formed do not necessarily imply any regenerative velocity effect, since the full inlet velocity, or one approaching thereto, may be maintained in them. On the other hand, there may be a fall in velocity, but, owing to resistances, no corresponding gain in pressure.

Several precautions require to be observed in designing an open tube bank. In the first place, the collecting area for the condensate and the termination thereat of the steam passage or passages from the

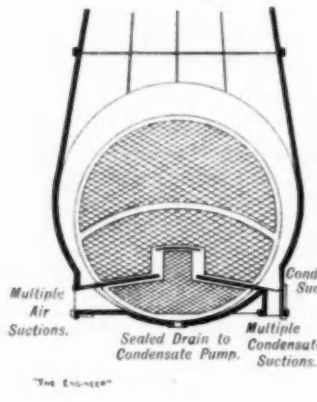


FIG. 15

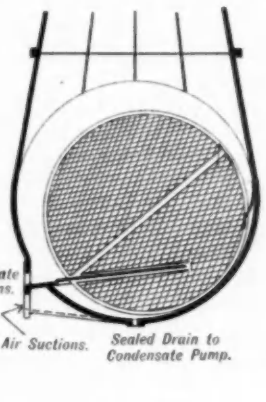


FIG. 16

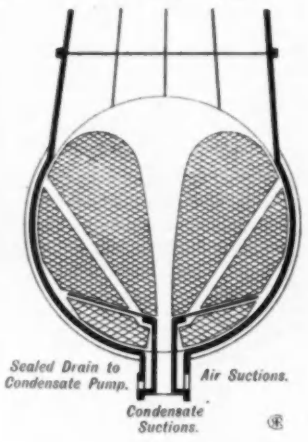


FIG. 17

inlet branch should be separated as widely as possible from the inlet to the devaporiser, thus giving, in effect, an arrangement whereby the condensate is extracted at approach instead of at exit from the main tube bank. If the collecting area is left in its usual position adjacent to the devaporiser inlet and a steam passage thereto opened up through the tube bank, inlet steam will obtain direct access to the devaporiser, thus partially revaporising the residual mixture. Under these conditions the mixture must arrive at the devaporiser already devaporised to a sufficient extent to compensate for this subsequent revaporising—in other words, such an arrangement yields a design involving two successive devaporisation processes, one of which, while it may be only partial, is conducted in what should be the primary section. Hence the design is unfavourable to high condensate temperature, unless under conditions of exceptional air tightness, and tends to be wasteful of surface. Examples of correct relative position of condensate collecting area and devaporiser inlet appear in Figs. 15, 16 and 17. The passage or passages conducting inlet steam to the collecting area should be of generous width at their upper or inlet ends, and should not converge too rapidly as they approach their destination. The combination of great length and relatively small width in such a passage may, because of the outflow of steam at the sides of the passage owing to local plenum, cause it to fail of its intended purpose.

With the abandonment of the closed tube bank the strict observance of the counterflow principle necessarily disappears on the steam side of the tubes, unless the formation of steam passages through or round the tube bank is accompanied by a corresponding modification of the water passes. Where the normal arrangements with regard to these are continued, the tube bank becomes what is virtually an assemblage of separate condensers operating in parallel upon steam of approximately uniform temperature and air content, but with varying temperatures of circulating water. Many condensers having nominally closed tube banks, but employing large crescent-shaped approach passages, depart from the counterflow principle to a certain extent by the admission of inlet steam direct to the first pass *vid* the flanks of the approach passage, and the division space between the passes. The use of deep steam lanes may have a similar effect. In sub-dividing the tube bank into separate blocks by steam passages, with a view to securing regenerative operation, care should be taken that no individual block becomes completely isolated, and thus deprived of a free outlet to the devaporiser for the aerated residual mixture deposited in it, otherwise such blocks of surface will tend to become more or less air-logged and inefficient, and thus to exercise a prejudicial effect upon condensate temperature and the general efficiency of the process of condensation, as well as rendering the condenser unduly sensitive to increased air leakage. In other words, there should be a general flow from all parts of the condenser towards the devaporiser, a condition which is hardly compatible with blocks of surface entirely surrounded by passages to which inlet steam has access.

In a special form of condenser developed in the United States of America the tube bank is purposely built in the form of a group of separate isolated cylindrical tube blocks, thus securing a tube bank depth of approximately a quarter of the diameter of the shell, but the danger just described is avoided by the provision of separate air suctions to each tube block. With this design, however, a portion of the condensate traverses the devaporisers formed at the centres of the tube blocks, and is thus subject to the cooling effect of secondary surface.

When, owing to the conditions of operation, the secondary section is automatically extended beyond the devaporiser proper, and thus includes surface normally forming part of the primary section, the heat transmission coefficient over such included surface is greatly reduced, the major part of the heat actually transmitted probably coming from the film of condensate traversing the tubes. Where a considerable body of primary surface is situated above the extension, this film will be relatively thick and a large amount of condensate will be subjected to under-cooling. This explains the fact that, where such conditions exist, the condensate temperature may be many degrees below the air-vapour temperature which obtains after the residual mixture has been subsequently passed through the devaporiser proper. Any great concentration of primary surface above the zone of possible extensions of the secondary into the primary section should therefore be avoided as far as possible.

Such arrangements as have been described up to the present would have, as their maximum possible achievement, a condensate temperature at or closely approaching that corresponding to the vapour pressure at approach to the tube bank. As shown in Figs. 15, 16 and 17, they are applicable to tube banks having primary sections of conventional design, and with no arrangements for the reduction of resistance beyond diminishing the average length of steam track by the employment of crescent or vee-shaped approach passages and the customary differential tube spacing. This latter feature has not been indicated in the diagrams, in which the occupied areas of the tube plates are merely shown by a system of conventional cross hatching.

Such regenerative action as these condensers secure is obtained in the true sense of the term as originally applied to condenser work—that is, by a species of secondary jet condenser action, whereby condensate which has been under-cooled by direct passage of heat at the transmitting surfaces is reheated by contact with inlet steam in the tube bank or steam passages, and the heat so added conserved by collection and extraction under inlet vapour pressure. The separation of the collecting area and the inlet to devaporiser also reduces to a minimum the portion of the total condensate diminished in temperature by evaporation on contact with vapour which has fallen in pressure owing to resistance and air concentration.

Regenerative action in the larger and more inclusive sense, however, should also connote the provision of means for utilising as great a portion as possible of the kinetic energy of the entering steam, in raising the thermal level of heat rejection at the condenser relative to that at the last revolving wheel of the prime mover.

Taking the conditions at exit from the latter as fixed, attention should be concentrated on the entire passage thence to the first row or rows of tubes in the condenser as the field in which the maximum energy reconversion is to be sought, since here the kinetic energy of the whole body of the steam is available. The utmost diffuser action should be promoted by suitable gradation of cross-sectional area, avoidance of abrupt changes of direction and form of cross section, and by confining the staying arrangements to the necessary diaphragms, properly formed and placed, for the purpose of limiting the divergence angle of the passages. Diffuser diaphragms have been indicated diagrammatically in the sketch designs of Figs. 15, 16, 17, and other designs will be given and discussed in a later article.

These measures will involve a closer collaboration between the turbine and condenser designers than frequently exists. As a logical consequence, they would also appear to indicate the taking of the temperature corresponding to the vacuum immediately at exit from the last wheel, and comparing it with the temperature of the condensate, as the most suitable criterion of condenser performance. This would avoid the difficulties of comparison based on vacuum readings at exhaust flanges arbitrarily fixed, since it is evident that a condenser in which the velocity at the exhaust branch has been greatly reduced with respect to that at issue from the last wheel has available in itself a greatly diminished field for regenerative velocity effects. In any case, if the usual method is retained, the velocity at the exhaust branch should be duly taken into account in assessing condenser performance.

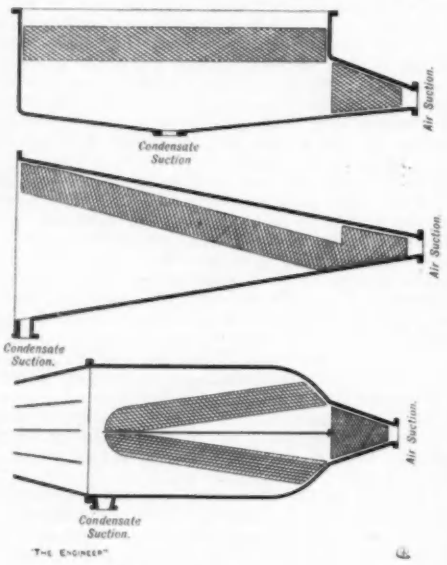
The regenerative velocity effect obtainable in the turbine exhaust branch and the approach passage of the condenser will increase with the difference between the squares of the velocities at exit from the last wheel and at approach to the tube bank, thus indicating that the approach area should be as large as possible. It has been shown in Section 6 that the resulting low entrance velocity leaves little scope for regenerative velocity effect in the tube bank itself. The range of velocity actually available, however, will be greater, and the average velocity through the tube bank lower, the lower the velocity of exit. Moreover, the shorter the steam track over which a given conversion of velocity to pressure energy takes place, the less will the resulting gain in pressure be outweighed by hydro-dynamical resistance. All these considerations combined point to a tube bank of rectangular cross section, as shown diagrammatically in Fig. 18, and having a maximum transverse area and a minimum depth in line of steam flow, as being the generic form for employment in regenerative condensers. Such a type has also the advantage that deposited condensate traverses a minimum of cooling surface before leaving the tube bank, and that the low resistance secured by low average velocity and short steam track, apart from any velocity effect, raises the average temperature of deposition, besides reacting favourably upon the whole process of energy transformation. In Fig. 18 the condenser is shown arranged for extraction of the condensate at exit from the main tube bank, thus exposing it to slight under-cooling by direct transmission, by preliminary air concentration, and by resistance if this exceed the regenerative velocity gain in the tube bank. True regenerative reheating as the condensate falls through the steam space below the tube bank is only possible to the extent to which the loss of heat by direct transmission brings the condensate below the temperature corresponding to the partial vapour pressure at exit. Such a condenser requires a large and efficient devaporiser, and, in addition, should always be associated with special endeavours to keep the air leakage within the air concentrating capacity provided.

Figs. 19 and 20 show further diagrammatic types embodying the generic tube bank form, but arranged for collection and extraction at approach.

In both cases the condensate, if below exhaust

inlet temperature on leaving the tube bank, is regeneratively reheated in falling across the approach passage on its way to the condensate suction, also in Fig. 19, and in the lower block of the primary section of Fig. 20, no deposited condensate traverses surface or passes through vapour of lower temperature than its own at the time of deposition. Collection and extraction at approach ensures that the supernatant partial air pressure under which these operations take place is a minimum, and that the condensate, therefore, in accordance with the law of Dalton and Henry, is saturated principally by vapour of the liquid, thus promoting the attainment of a non-corrosive working fluid.

In view of the small regenerative velocity effect available in the tube bank, as compared with the cooling influences to which the condensate is exposed when collected at exit, condensers of the type of



FIGS. 18, 19 AND 20

Figs. 19 and 20 probably constitute the best arrangement, particularly as they are also less sensitive to increased air leakage.

In practice, however, when provided with efficient devaporisers of ample capacity, and operating under normal conditions as to air leakage, the relative advantages of the two arrangements are somewhat nicely balanced.

Unfortunately, the apparent facility with which the effects sought are obtained is partly due to the abnormal direction of flow employed in the diagrams in order to illustrate the principles involved, and similar effects are not so easy of complete attainment in condensers of conventional shell form and inlet aspect. The disadvantages involved in the deep tube banks of large units have long been recognised, of course, and various steps taken have been to avoid or mitigate them. In a cylindrical condenser, the employment of a crescent-shaped approach passage, carried sufficiently far round the tube bank, reduces the average length of the steam track to about 0·64 of the diameter. An excentric annular approach passage, with radial flow, gives a tube bank depth of half the diameter, and an instance has been mentioned already in which a depth of one-quarter of the diameter was obtained. Condensers of semi-circular, boat or bowl-shaped cross section facilitate the attainment of a large approach area, combined with a relatively shallow tube bank, without departing greatly from customary arrangements in the primary section. Another method, developed more particularly in connection with double-flow low-pressure turbines, involves the use of twin condensers. With the same length between tube plates, cylindrical twin condensers have a diameter about 0·7 of that of an equivalent single unit. Large vertical twin condensers have also been fitted to both single and double-flow turbines, and lend themselves to a very efficient form of exhaust passage. Vertical condensers are not favourable to true regenerative reheating in the condenser itself, since the condensate flows down the tubes and not across the spaces between them. The fact that the condensate is finally collected upon the cooled surface of the lower tube plate also involves reheating in a separate chamber, by direct contact with inlet steam by-passed from the main exhaust.

(To be continued.)

WORK is progressing rapidly on the construction of Windsor–Detroit vehicular tunnel between Canada and the United States, and it is to be completed in 1930. The work is said to be ahead of the schedule time, 35 per cent. of the dredging of the trench in the Detroit River being already completed, and the concreting of the section of the river tunnel to be sunk at the foot of Randolph-street, Detroit, is nearly completed. The second section of steel tube will be ready for launching shortly, and a considerable portion of the third section has been completed.

Institution of Naval Architects.

No. II.*

AFTER luncheon on Wednesday, March 20th, Lieut.-Colonel Dondona read a paper on "Sea Trials of Italian Destroyers," of which we give an abstract below.

SEA TRIALS OF ITALIAN DESTROYERS.

In this paper the results of the trials carried out with three types of Italian destroyers representing in all sixteen ships, built between 1925 and 1928, are set forth and discussed. For two of the types of ships considered, it has been possible for the first time in the Royal Italian Navy to carry out the systematic observation of the thrust generated by the propellers at different speeds by recording the thrust meters applied to the thrust blocks. The characteristics of the three types of destroyers tested are given in the following table :—

	First type.		Second type.		Third type.	
	"Sella."	"Crispi."	"Sauro."	"Manin."	Turbine "Espero."	"Borea."
Length at flotation, metres	84·54		90·15		93·20	
Breadth outside of plating, metres	8·63		9·20		9·21	
Mean draught under keel, metres	2·90		3·24		3·27	
Displacement, metric tons	1150		1300		1360	
Wetted surface of hull, square metres	802·15		887·5		923	
Area of immersed midship section, square metres	20·91		23·22		23·46	
Ratio : Length to breadth	9·80		9·80		10·12	
Draught to breadth	0·336		0·353		0·355	
Length to draught	29·12		27·79		28·52	
Block coefficient	0·532		0·471		0·473	
Prismatic coefficient	0·634		0·605		0·606	
Waterplane area coefficient	0·730		0·735		0·731	
Midship section coefficient	0·837		0·780		0·779	
Pitch of the screw, metres	3·400	3·600	3·300		3·600	3·300
Diameter of the screw, metres	2·900	3·000	3·000		3·000	3·000
Ratio : Pitch to diameter	1·172	1·200	1·100		1·200	1·100

The ships of the first type were built by the Cantieri Pattison, of Naples, and have exactly similar hulls, the only difference existing between the first three—"Sella," "Nicotera," "Ricasoli"—and the fourth—"Crispi"—being in the propelling machinery. The turbines of the first three are of Parsons geared type, whilst those of the fourth are of Belluzzo type.

The ships of the second type, of Odero design, were constructed, two by the Cantieri Navali Odero, of Genova-Sestri—"Sauro" and "Battisti"—and the other two by the Cantieri Navali del Quarnaro at Fiume—"Manin" and "Nullo." The ships of the third type, also of Odero design, were built to the number of eight, of which two—"Turbine" and "Aquilone"—by the Cantieri Navali Odero at Genova-Sestri ; two—"Nembo" and "Euro"—by the Cantieri del Tirreno at Riva Trigoso ; and four—"Borea," "Espero," "Zeffiro," and "Ostro"—by the Cantieri Navali Ansaldo at Genova-Sestri. Amongst the latter, the "Borea" differs from the others because it has carried out its trials with propellers differing from those of the other ships.

From the measured mile trial result curves have been plotted for each of the ships referred to in the table, and these are reproduced in the paper. We have chosen those for the "Sauro" as being generally typical of the series. In Fig. 1 there have been plotted as a function of the speed of the ship in knots V :—the number of revolutions per minute n ; the percentage slip $\frac{60\,n\,p - 1852\,V}{60\,n\,p}$; revolutions per knot $\frac{n}{V}$; the power read from the torsion meter in shaft horse-power S.H.P. ; the power deduced from the readings of the thrust at the thrust meter in horse-power, T.H.P. ; the towing power deduced from the tank trial curve for the bare hull, *i.e.*, without appendages, in horse-power, E.H.P. ; the coefficient of towing, $\frac{E.H.P.}{T.H.P.}$ the coefficient of propulsion, $\frac{T.H.P.}{S.H.P.}$; the total propulsive coefficient, $\frac{E.H.P.}{S.H.P.}$; and the value of the Admiralty coefficient $C = \frac{D^{\frac{2}{3}}\,V^3}{S.H.P.}$.

Fig. 2 is representative of another series of curves in which some of the curves in Fig. 1 are plotted so as to read as a function of the number of revolutions per minute, and on this diagram additional curves have been added representing the value of the Admiralty constant referred to the power for towing in the tank, $C_E = \frac{D^{\frac{2}{3}}\,V^3}{E.H.P.}$; and the value of the Admiralty constant referred to the power deduced from the reading of the thrust at the thrust meter, $C_T = \frac{D^{\frac{2}{3}}\,V^3}{T.H.P.}$. In tables included in the paper the characteristics of the different hulls at a constant displacement of 1200 tons are given and the principal factors deduced from the curves given are collected in tabular form.

After comparing the results obtained, the author calls attention to a characteristic phenomenon, which is shown by the direction of the curves representing T.H.P., which are plotted from the formula $T.H.P. = \frac{\text{Thrust in kilos.} \times 1852\,V}{3600 \times 75}$. From the curve reproduced in Fig. 1 it will be seen that the last part of the curve, in the neighbourhood of the maximum speed reached by the ship, has an evident tendency to droop and maintain itself parallel to the axis of the abscissæ. It is pointed out that if the curve were to assume a decidedly horizontal direction, it would signify that there was, in effect, a diminution of the thrust, which would tend to compensate for the increase of speed. This, however, it is remarked, would be an absurdity, and, in fact, it does not actually happen. It is shown, however, that the thrust has a tendency to remain constant, so that the T.H.P. values increase only because of the increase of speed. It is extremely interesting, the author remarks, that this phenomenon occurred with all the ships on which it was possible to make exact measurements of the thrust, because it may lead to some unforeseen explanation of the phenomenon of propulsion at high speeds.

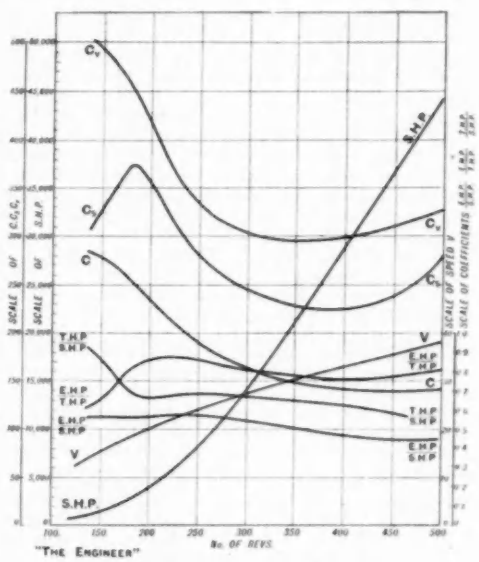


FIG. 2—CURVES FOR "SAURO"

In fact, if the same results were obtained with other hulls also, it might be concluded that the ship at those speeds is subject to an acceleration without an increase of thrust, and that all the work expended in power transmitted to the propellers, which increases greatly with the increase of speed, is expended by the propellers without being transmitted to the ship. But since the propellers work in water, and that, in addition to vortical motion, they set up a current directed from the bow toward the stern, it might be concluded that at this speed there is established a kind of equilibrium between the thrust which the propellers transmit to the hull, and that which they exercise

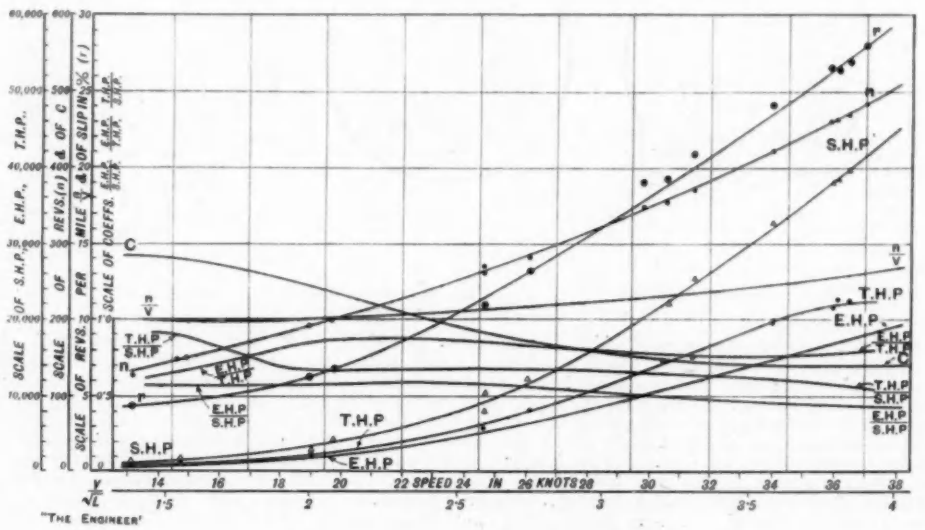


FIG. 1—CURVES FOR DESTROYER "SAURO"

* No. I. appeared March 22nd.

on the liquid mass in which they are working, since this liquid mass is no longer in a condition to give to the propellers that reaction necessary to set up the thrust on the ship.

In other words, there would occur a yielding of the support, and with the increase in the number of revolutions per minute and the power transmitted by the shaft, a stream of water would be absorbed from the bow and forced toward the stern, so that the ship would then no longer be propelled by the propellers, but sucked forward by the lowered pressure caused in the mass of water by the effect of suction produced by the propellers.

That this means of propulsion is very inefficient is evident by reason of the great expenditure of power which is required at high speeds without the ship receiving any increase of thrust from the propeller. It should cause those designers to hesitate, who maintain that it would be possible advantageously to devise a form of propulsion based on the principle of creating with a vacuum or a lowering of pressure a suction ahead of the ship, instead of pushing against the water in order to use its density for the creation of a thrust.

Sir William Berry said that the spirit in which such a large amount of data obtained during the trials of sixteen recently built Italian destroyers had been set before the Institution with a view to co-operation in the study of the complex phenomena of ship propulsion was highly commendable. Referring to the author's doubts as to the reliability of the thrust indicators used on the trials, he said that in connection with the trials made for the British Admiralty there was also great trouble in finding out from the indicators what the thrust really was. The shaft horse-power obtained on the trials of the Italian destroyers had reached 52,500. In the British Admiralty destroyer before the war it had reached 35,000, but since the war, in the "Amazon," it had reached the neighbourhood of 40,000. The "Borea" was very much of the same dimensions as the later ships in the British service. The falling off in the thrust at high speed, to which the author had referred in the concluding paragraphs of the paper, was a curious phenomenon which did not admit of any obvious explanation. Model experiments indicated a progressive falling off in the augment of resistance caused by the screws as the speed increased, but the change was too gradual to account for the existence of no increases of thrust with speed. Colonel Dondona's suggested explanation would imply a fairly rapid reduction in the augment, and that reduction should be reflected in the model screw experiments. Unless we believed that there was a large-scale effect between the augment of resistance as measured for the model and that which obtained in the ship, the explanation given could hardly be the true one. The vessels of the third type referred to in the paper—the "Borea," for example—approximated to the Admiralty "W" class, which had been the standard type of destroyers in this country since 1917. In the British service, however, only two destroyers, the "Amazon" and "Ambuscade," had been completed and had run trials since that time, so that we were not in possession of such a comprehensive series of modern trial data as the Italian Ministry of Marine. It had been observed that it was the rule rather than the exception to experience cavitation in that type of vessel at the top speeds. Cavitation was experienced in the earliest torpedo boats, and the two main factors affecting it were considered to be the pressure per unit area of the propeller blade surface and the tip speed of the propellers. The value of Colonel Dondona's paper would be enhanced if the blade area of the screws were given, and that would enable the first factor to be deduced. The tip speeds were high, reaching over 15,000 per minute in some cases. In the "Amazon" it reached about 14,000ft. per minute, and in the "Ambuscade" about 13,000ft. per minute, and each of those was higher than the usual standard in Admiralty practice. Analysis of the Italian results on the usual basis of the British Admiralty appeared to indicate the existence of very severe cavitation in most of the vessels, as at the higher speeds the measured thrust was much lower than that calculated approximately from the propeller dimensions, speed and revolutions, whereas at low speeds there was fair agreement. It was significant that the best performance, that of the "Crispi," was associated with the lowest tip speed, and the worst performance, that of the "Borea," with the highest. With vessels of such high speeds a considerable depth of water was required, as otherwise the maximum speed obtainable would be affected. The well-known experiments of Colonel Rota indicated that at the speed-length ratio obtaining for those trials a depth of water would be required comparable with the length of the ship. He asked, therefore, what was the depth of water in which the higher speed trials were made.

Mr. Harris G. Williams asked for further propeller particulars, as, for instance, the number of blades, the boss diameter and thickness of blade, as they were necessary for making a complete analysis of the results.

Mr. S. V. Goodall asked what was the Italian practice in regard to the contract conditions for torpedo-boat destroyers and their trials. Was the Italian Ministry of Marine responsible for the dimensions of the ship, the form, the power of the machinery and propeller particulars, so that the contractor was merely responsible for the attainment of the required shaft horse-power, and was not responsible for speed; or did the Ministry specify the general characteristics required and leave the contractors to decide the form, propeller particulars and machinery, subject to covering approval by the Ministry, in which case the contractors would be responsible for attaining the required speed? He mentioned that because Table II. in the paper indicated a marked difference between the prismatic coefficients of the three types of vessel. If all three forms had been designed by the Ministry of Marine he deduced that the change from the high prismatic of Type 1 to the low prismatic of Type 3 indicated a development of ideas, but if the forms had been designed by the different firms, it might merely indicate that the naval architect of the firm designing one type had different views from those of the naval architects of the firms designing the others. Reference was made by the author to the conditions of contract and contract displacement, and he had stated that trials were carried out at progressive speeds with the "Crispi" at the contract displacement, and with an increased displacement very near that which the ship would reach on service. Mr. Goodall asked, therefore, whether the propellers were generally designed for the contract conditions or for the conditions the ship would reach on service. He also asked for particulars of the torsion meters and thrust meters used, and the degree of accuracy which the author considered was attained. It would appear that the torsion meter results at low speed were not particularly reliable. With regard to appendage resistance, an addition of 12 per cent. to the resistance of the bare hull, as in the case of the "Sella," seemed to be rather high, unless it included an allowance for wind resistance. He asked if wind resistance had been taken into account. Finally, he asked how, in his form of analysis, the author detected when cavitation set in, and determined its degree.

Dr. E. V. Telfer was gratified to find Italy emulating America's sporting spirit by chronicling her experience and so contributing to science. There were many points of extreme scientific interest emerging from the paper. For example, inspection of the curves of predicted resistance showed that in four cases out of seven the model was clearly at fault, owing to laminar breakdown at low speeds. That was evident from the fact that the Admiralty-constant curve must rise from the lowest speeds and pass through a maximum when the rate of decrease of viscous specific resistance equalled the corresponding rate of increase of inertia resistance. The four faulty cases did not show that maximum, but it was significant that practically all the ship power and thrust measurements definitely indicated its existence. With regard to the phase difference between the minimum Admiralty constants for resistance and thrust respectively, he suggested that that was an inevitable consequence of the use of the Froude coefficients of ship frictional resistance. Those coefficients gave far too rapid a drop in specific viscous resistance with increase in speed, and it was that rapid drop that caused all the features of the resistance curve to occur at lower speeds than was actually the case in the ship. In that connection the author had commented upon the fact that the minimum Admiralty constant was only reflected in the case of one shaft horse-power curve, that of the "Crispi." He had not offered any explanation of that, but the obvious reason was the sharp occurrence of incipient cavitation in all cases, "Crispi" included, at speeds between 28 and 29 knots. That could be demonstrated strikingly by plotting shaft torque constants against apparent slip. The better performance of "Crispi," however, would appear to be due to her low real slip at all speeds prior to cavitation being on the low side of the efficiency maximum, and as cavitation occurred the propeller efficiency maximum was approached, with a consequent gain in overall efficiency. It was curious, however, that despite cavitation the thrust Admiralty constant should follow the resistance curve and not the shaft horse-power curve. It was still more curious that at the highest speeds of all the thrust deduction should definitely decrease, the thrust itself practically remaining constant, despite a definite speed increase, which required definite power, revolutions, and slip increase for its realisation. He was not at all convinced that that phenomenon was genuine, despite its having occurred in all cases, and, whilst not doubting the actual thrust measurements, he suspected seriously their interpretation. It was well known that from and at speeds higher than the minimum resistance Admiralty constant, vessels of that class would squat sharply and acquire an increasing trim of the stern. Had that dynamic trim been allowed for in correcting the measured thrust of the shafting weight component? If such a correction were omitted, that would explain the apparent drop in thrust.

Monsieur Salmon Legagneur, referring to propellers, drew attention to the question of the thickness of the blades, and said that in the French Navy a much better efficiency had been obtained in various cases by increasing the thickness of the blades. Discussing the hull, he asked if special precautions were taken to reduce the volume of the appendages in the later destroyers. As to the conclusions drawn from the paper, he pointed out that in the propeller designed for the "Crispi," the ratiof pitch/diameter was the highest (1·2), and it had given the best result for the maximum speed. In the propellers on the French destroyers the ratio pitch/diameter was as a rule a little higher than that, and so far as he knew, their efficiency was very similar to that recorded by Lieut.-Colonel Dondona. With regard to the maximum recorded on the curves of E.H.P./S.H.P. and T.H.P./S.H.P., he considered that the design of propellers should be carried out so that the maximum might be as near as possible to the normal cruising speed of the ship. He imagined that the normal cruising speed of those destroyers was between 15 knots and 20 knots.

Lieut.-Colonel Dondona, replying to Mr. Goodall, said that the contractors were responsible generally for the design and for the speed attained. They were asked to provide a ship giving a certain minimum performance. The torsion meters used in the trials were of the Denny-Edgcumb type. The figure of 12 per cent., representing the increase of resistance due to the appendages in the "Sella," was a little high, but generally the wind resistance was included in that figure.

Lieut.-Colonel Dondona intimated that he would reply to the discussion in more detail in a written contribution.

A hearty vote of thanks having been accorded the author, the meeting adjourned until Thursday.

The President (Admiral of the Fleet the Right Hon. Lord Wester Wemyss) was in the chair on Thursday morning, March 21st, when a paper by Mr. J. Johnson on "The Propulsion of Ships by Marine Steam Machinery," was read by Mr. J. Hamilton Gibson, in the absence of the author through illness. A long abstract of this paper is given on page 360.

STEAM PROPULSION OF SHIPS.

The President, in calling upon Sir John Biles to open the discussion, congratulated him and the Institution upon the fact that he had just completed the jubilee of his association with the Institution.

Sir John Biles said the installation described in the paper was a combination of Scotch boilers with water-tube boilers for the purpose of securing a pure water supply. He noticed that Mr. Johnson had reduced the amount of Scotch boilers in the total combination from 6 or 7 per cent. in his earlier and smaller powered combinations to something like 3 per cent. in the higher powered combination, and perhaps he was tending in the direction of doing away with the Scotch boilers and relying upon evaporators. It was to be hoped that the paper would provoke the Diesel engine people to come forward and defend their side of the question and produce those figures which were so badly wanted. A very valuable figure given by Mr. Johnson was the amount of loss in make-up feed, namely, 35 tons, which was just 2 tons per 1000 H.P. That was a great improvement on the usual figure taken as 4 tons per 1000 H.P., and no doubt in time it would be still further reduced, because it was a most important factor, especially in the case of those ships which insisted upon carrying all the fresh water they wanted to use. With regard to the weights given in Table IV. for powers ranging from 11,000 H.P. to 20,000 H.P., he thought the figures would be much reduced in the higher powers. It was possible, he believed, to get down as low as 0·1 tons per S.H.P., but there was no reference in the paper to powers of 30,000 H.P. upwards. It had frequently been pointed out, however, that with the higher powers there was a very great reduction in the weight of the turbine machinery, whereas with Diesel engines of big powers there was not that same reduction.

Sir Charles Parsons said all lovers of steam would congratulate the author on an epoch-marking paper. The Diesel engine undoubtedly had a field for moderate powers. The Bauer-Wach system was proposed by his firm in 1906. Anyone who cared to inquire would see from his 1906 patent that every possible means of using low-pressure turbines in combination with reciprocating engines was described and hinted at. The scheme was not very attractive, because the reciprocating engine was limited in pressure by the lubrication problem. The higher the pressure of the steam, the more lubricant was required and the more difficult it was to lubricate. More than 100 years ago Perkins worked in that field on the Tyne, and one ship was fitted for 1000 lb. pressure, but it was not a success for the reason he had mentioned. With the turbine there was no such difficulty, and it could be made to suit any pressure. The author was undoubtedly correct in prophesying that we shall go to higher steam pressures and temperatures. That would come when new alloy steels were available, and were cheaper than at present, for the last part of the superheater. The turbine could be made to stand almost any temperature by means of alloy steel. With regard to evaporators, Mr. Johnson had chosen an admirably straightforward method by using the Scotch boiler, but there was a considerable advantage in using low-pressure evaporators. The only thing about them was that they must be of very large capacity, so that if salt water was being evaporated, the feed would not be contaminated by salt. The low-temperature evaporator was a very much more efficient way of getting fresh water than a Scotch boiler, because the engine was robbed of only a small amount of energy. There were the same thermal units practically all the way down the curve until the last part.

Mr. Harold Yarrow said that when it was learned a few years ago that the Canadian Pacific Steamship Company had ordered four liners with high-pressure

water-tube boilers, and five cargo boats, also with water-tube boilers—three of which were to be equipped with mechanical stokers—it was thought that Mr. Johnson, the superintendent engineer, was taking a very bold step in equipping the whole of this important fleet with this type of steam generating plant, but his confidence in the water-tube boiler had been more than justified. It was of interest to note the tendency in the direction of bigger boiler units and the simplification that can be obtained. The steam pipe arrangement shown in Figs. 1 and 2 of the paper was very striking. Such vessels as the "Majestic" or the "Berengaria"—each of which was equipped with about forty-eight water-tube boilers—would to-day only need about one-third of that number for the same total heating surface, and the saving by a small number of larger units was clearly shown in Mr. Johnson's figures of cost. In addition, there was a great saving in space, the installation was much simpler and the boiler efficiency higher on account of each unit being larger; 86 or 87 per cent. efficiency on the gross calorific value of the fuel could be guaranteed. The result of the trials of the "Viceroy of India" held a few days ago, in which the turbo-electric drive had been adopted, was another instance of a highly successful result with steam. That vessel, which was equipped with high-pressure Yarrow boilers, had shown a very high efficiency, which more than confirmed the figures given in Mr. Johnson's paper.

For large and fast liners no doubt oil would continue to be used for some time, either in boilers or Diesel engines, but if for other types of vessels coal could be used in some form or other, then the advantages on national grounds alone would be enormous. Hand firing would soon be looked upon as a thing of the past, and either pulverised coal or mechanical stokers would have to be adopted. The use of pulverised coal in Scotch boilers had already made headway, but it appeared to be only the stepping stone to the adoption of water-tube boilers, even for moderate steam pressures, especially as that type of boiler with its large combustion space was more suitable for either pulverised coal or mechanical stokers. One objection to water-tube boilers that had been raised was the presence of salt water. In that connection it might be of interest to state that salt water had been used in a Yarrow boiler working at 200 lb. pressure for many days continuously with no injurious effect on the tubes. That experiment confirmed the conclusion arrived at by the Committee on Naval Boilers, which reported as follows:—"The report on the trials of the 'Medea' and 'Medusa' contains a description of experiments made on the Yarrow and Durr boilers in regard to their behaviour when working with brackish water. These experiments, so far as they went, indicated that neither type of boiler was likely to give trouble from this cause. In the case of the Yarrow boiler, this result has been corroborated by the fact that on a recent voyage the 'Medea' is reported to have had leaky condenser tubes and a corresponding density in the boilers without any bad effect." At moderate pressures and at low rating of boilers in the merchant service, salt water was not so serious as was often thought, providing there was good circulation of water in the boiler.

Sir Robert Dixon said that one of the main bogeys advanced against the water-tube boiler and high-pressure steam was the trouble experienced with condensers. It admittedly had been a very real trouble, owing to the presence of salt water, in spite of what Mr. Yarrow had said. The author, however, pointed out that, thanks to the use of alloys for condenser tubes, different from those formerly used for that purpose, the trouble had been almost eliminated. Reference was made in the paper to the use of cupro-nickel tubes with 20 per cent. nickel. Some years ago the Admiralty carried out some trials with cupro-nickel tubes with the nickel varying from 20 to 50 per cent. Experiments were also carried out with Monel metal tubes. Four years' experience of these was very satisfactory indeed, and he agreed with the author that the trouble with condenser tubes was practically eliminated, thanks to the use of these alloys. On the whole, he was inclined to think, personally, that the Monel metal tubes, which contained 70 per cent. of nickel, were slightly better than the cupro-nickel tubes with 30 per cent. of nickel. If we could eliminate condenser troubles, de-aerate the feed water, and eliminate oil, he saw no reason whatever why the life of boiler tubes should not be, say, twenty years. The author, however, appeared completely to have eliminated the oil, and the use of the Scotch boiler in that connection was, in his opinion, only an intermediate step. In the Navy twenty years ago a combination of Scotch and water-tube boilers was used, but the Scotch boilers gave quite a serious amount of trouble, with the result that they had been entirely dropped. The figure of 4 tons per 1000 H.P. as loss in feed water, mentioned by Sir John Biles, was extraordinarily high. It was a limit which used to be allowed in Admiralty specifications, but generally speaking the actual loss was certainly less than half that amount. The Diesel engine was undoubtedly a serious competitor with the steam engine for low-power vessels, but for high-power vessels it would never compete successfully with the high pressure steam turbine.

Sir Archibald Denny said that, having been closely associated with Sir Charles Parsons for so many years, and having had the honour of building the "George V.," which really gave the kick to high-pressure steam, it was very gratifying to know Mr. Johnson's experience. His own firm also built the "Beaverburn," which was mentioned in the paper, and as representing a firm which built any class of engine, he could say that for certain trades the Diesel engine had it, whilst for others steam had it.

Engineer-Captain William Onyon said the feature of the paper which appealed to him most was the manner in which engineers unaccustomed to the type of machinery in use had taken the vessel across the Atlantic just as if they had been used to it all their lives, and it was a great tribute to the adaptability of the marine engineer. He regarded Mr. Johnson's combination of cylindrical boilers in conjunction with water-tube boilers as a simple stroke of genius. The boilers were fed with pure distilled water, and in the Navy they used to fill up the boilers with zinc slabs and lime.

Mr. W. J. Willett Bruce said the author had established one thing, namely, the necessity of a tight condenser. A leaky condenser, even under low pressures of 200 lb. or 250 lb., was a very serious drawback for a Scotch boiler. It was obvious that there was no alternative for high speeds and high powers to the water-tube boiler. One large installation of boilers, which at one time had been under his care, had now been in commission for seven years, and it steamed many thousands of miles. During those seven years the boilers had been working most satisfactorily, and reflected great credit on those responsible for handling and working them. It had not been necessary to renew one single tube in that installation in that period. He referred to the "Majestic" which was now in Southampton undergoing a very extensive overhaul. Some of the tubes which had been taken out did not show the slightest depreciation as a result of seven years in commission. The reason, he believed, was the care which was taken in operating those boilers. Never had a drop of salt water or brackish water entered the boilers. Distilled water was used from the start, and very careful records were taken from hour to hour, so that the slightest change in the feed water was at once observed. He did not agree with the author that water-tube boilers should be capable of steaming for six months without cleaning. That was rather too long a period, and in the installation he had referred to, the rule had been laid down that the boilers should not be under steam for more than six weeks without external and internal cleaning of the tubes. Mr. Yarrow was correct when he stated that such a ship as the "Majestic," if higher pressure steam was adopted, could operate with a materially reduced number of boilers. Some years ago he got a certain amount of information on that subject from Messrs. Yarrow, and it was shown that with 350 lb. pressure, instead of an installation of forty-eight water-tube boilers, a similar amount of work could be done with twenty-three for the production of from 86,000 H.P. to 90,000 H.P. That was a saving of one-third in space, owing solely to the adoption of higher pressures.

Mr. Sterry B. Freeman regarded the paper as likely to be a standard work of reference for years to come. The author, having had experience of working out the scheme he described, was going on to still larger ships engined on similar lines, and his experience was very encouraging. What emerged particularly from the paper, in his opinion, was the fact that the choice of marine machinery must depend primarily on the conditions of service of the ship. In the first place, there was the bunkering problem. Would Mr. Johnson say what his experience had been of the coalowners' willingness to help? Had the cost of coal suitable for his grates gone up since he had committed himself to them, and could the shipowners rely on buying small coal at cheap rates when small coal was essential? Even if the weight of bunkers was only 30 per cent. higher for turbines than oil engines, it was still a big handicap for British owners trading against foreign owners using oil engines. As regarded conditions of service, on the North Atlantic trade the cold sea water meant a vacuum of 29 deg., whereas on the Far Eastern service, 27·5 deg. was the very best that could be looked for over three-quarters of the voyage. With regard to space, with oil engines it was possible to come within the 13 per cent. rule to reduce the registered tonnage of the ship. Incidentally, Mr. Freeman said he admired the clever combination of water-tube and Scotch boilers adopted by the author. Most good ideas were very simple and seemed obvious when expression had been given to them. As regards first cost, with good cargo liners, there were at present seven sister ships, turbine and oil engines, in which the cost of the two types was within 3 per cent. of each other. The oil engine had possibly been more expensive, owing to patent and similar restrictions, than it need have been. As regarded pulverised fuel, it was hoped that the economy in comparison with oil engines would be the subject of some investigation by the Marine Oil Engine Trials Committee. The cost of repairs would necessarily depend upon the engines in the ship and the man in charge of them. Comparing several sister-ships—turbine and oil engine driven—in the same trades, there was, if anything, a balance in favour of the oil engine, but certain oil engines and certain turbines had cost abnormal amounts. Oil engine builders did not come to these meetings and talk, but they went on selling their engines in steadily increasing numbers, although, as previously stated, the oil engine had its real field for smaller powers.

In the absence of the author, there was no reply to the discussion, but on the motion of the President a cordial vote of thanks was passed to Mr. Johnson, who, it was mentioned, was making good progress.

Dr. J. Bruhn then read a paper entitled "Some Considerations regarding International Loadline Regulations," of which an abstract follows:—

INTERNATIONAL LOADLINE REGULATIONS.

The opinion in practically all maritime countries seems now to be in favour of the establishment of some international understanding, which will prevent the overloading of ships in any port. The following remarks are therefore based on the assumptions that—

(1) International loadline regulations are desirable.

(2) Such regulations should as far as possible be clear and definite, so that harbour authorities of any port can apply them.

(3) The regulations should not cover more ground than necessary, to prevent undue competition in respect to the carrying of deadweight.

(4) The regulations should take the form of specific statutory requirements and should not be mixed up with general seaworthiness requirements.

There are practically only two alternative systems which can come into consideration when it is a question of establishing international precautions against the overloading of ships.

There is the system in which all countries have more or less divergent regulations, which are, however, on the other hand, so alike that each country can recognise every other country's regulations as providing equal safety to her own. This is practically the international loadline system so far as such a system can be said to exist now, and it may be a question whether the principle upon which it is based might not with advantage be retained also in any future system of international agreements. The main objection to doing this lies in the fact that the national freeboard regulations, as now existing, are so formed that they cover the conditions of the particular country, but they are more or less vague or non-existent when the vessel is trading in other than home waters. Outside these latter it is, as a matter of fact, to a larger extent than necessary, left to the master of the ship to decide how the regulations shall apply in the particular geographical locality he might be in and in the particular circumstances.

The other alternative for the establishing of international loadline regulations is the one in which all countries have, as far as possible, identical rules, whereby the limit to the loading should be the same for the ships of all nationalities at any particular port. If this system is to be applied in a reasonable manner, it must in some respects diverge from the national methods now in use in order that due consideration can also in this case be given to the local conditions of trade, types of ships, weather, character of waters, &c.

In examining the question as to which regulations will be the most satisfactory for the purpose of placing a limit upon undue loading, it is desirable to consider briefly the factors which determine the amount of freeboard a ship should have from a purely safety point of view, apart from statutory regulations. They may be divided into two groups, one mainly under the control of the naval architect and one mainly under the control of the master of the ship, but practically all the factors must be taken into consideration by both these persons.

In the first of these categories of factors are the following:—

The geometric dimensions and form of the vessel, including erections; means of closing openings in weather deck and sides; wash ports; general structural strength; means of propulsion; general character of waters to be frequented; general character of the trade in which the ship is employed; season of voyage.

In the other category are the following factors:—Stability; safe closing of openings; strength; propulsion (sail); particular trade in which the ship is employed; weather and sea; officers' competency.

These factors are discussed and the author sums up his conclusions on the enforcement and administration of international freeboard regulations as follow:—

It is undesirable to attempt to establish other international regulations than such as can be readily ascertained and efficiently enforced by the harbour authorities at any port.

When the rules for estimating the exact statutory freeboard, including the modifications for specific waters and for season conditions, as well as the rules for the exact form of the loadline marks have been agreed to internationally, it should be for the national authorities to see that their ships are duly marked in accordance with these rules, and to see that all ships in their ports, whatever their nationality, are being loaded not deeper than is indicated by the marks. It ought to be left to the national authorities to interpret the rules and to decide which geographical or season line shall apply in the particular place and at the particular time, taking all the circumstances into consideration, for which there exist statutory regulations. By an exchange of opinion from time to time the practice in the various countries might be kept sufficiently uniform.

The control of the loading of ships should, as far as the statutory regulations are concerned, be made at the port of departure, as that is the only place where the amount of cargo can be limited and outside control established with least inconvenience. Such control should also be sufficient, as the object of loadline regulations is to limit the amount of cargo taken on board. All the factors which affect the safe loading, but are not mentioned in the statutory regulations, must be allowed for by the master in his looking after the ordinary seaworthiness of the ship. A master might thus reasonably be fined if he allows his ship to be unduly immersed as a consequence of deck cargo absorbing moisture or as a consequence of the formation of ice. But it ought to be on the ground that he did not look after the seaworthiness, and not because he transgressed the statutory loadline regulations.

The port authorities might also ascertain that the ships have the necessary freeboard certificates and certificates showing that the strength of the hull and the closing means of all openings provided are in order.

It would be desirable if there were on all freeboard certificates a clear statement to the effect that the statutory freeboard is not necessarily sufficient for safety purposes, and that it must therefore be for the master to see that it is sufficiently augmented if the conditions in any particular case of ship, cargo, or surroundings make this necessary.

Sir Charles Sanders, referring to the suggestion in the paper that loadline regulations should take the form of specific statutory requirements and should not be mixed up with general seaworthiness requirements, said that all the efforts in this country with regard to loadline regulations had certainly been in the direction of preserving general seaworthiness of ships when loaded, although the rules did not contain regulations for preserving seaworthiness. It was agreed that international rules were desirable, and shipowners and successive Governments in this

country had emphasised the necessity for international agreement on the loadline. The suggestions for international rules made in the paper should have the support of the Institution.

Dr. Robb said, admittedly, safety was the paramount consideration, but it was also the duty of the shipowner to deliver all the cargo. Could the author say how many of the 400 ships he had mentioned working under the Norwegian freeboard rules for timber-laden ships had had to jettison their cargo.

Mr. J. Foster King said it was quite impossible to establish any theoretical principle for freeboard and the matter must be approached from the point of view of the object of such regulations, and that necessarily brought into consideration the particular type of service for which a vessel was intended. From a common-sense point of view it appeared to him that a ship with sails required more freeboard than a steamer only, however, at the time, she used her sails. But it seemed better not to complicate the question, having regard to the fact that there was motor power on board by considering the time when such a vessel used her motor power. As to reserved buoyancy, referred to by Dr. Robb, the 1915 loadline committee washed that out altogether as a measure of freeboard.

Dr. Bruhn, replying to the discussion, agreed with Sir Charles Sanders that there were difficulties in taking general seaworthiness into account when considering loadline regulations. In reply to Dr. Robb, he said he could not give details at the moment of the number of vessels which had had to jettison their cargo, but even so such statistics could not be used as definite proof one way or the other on the point raised. At the same time, had there been any serious losses due to the loading regulations mentioned in the paper, they would certainly have been known and used as an argument against them. As a matter of fact, he was certain there had been very few cases of the kind. There might have been cases in which the vessel was not suitable for the purpose to which it had been put, viz., the carrying of timber, and there might have been trouble.

(To be continued.)

Sheet Piling Cofferdams for the Sukkur Barrage.

WE have on several occasions, notably in our issue of August 25th, 1922, made reference to the Sukkur Barrage irrigation undertaking. The work comprises the construction of a barrage about a mile long across the river Indus, and of seven head regulators for the canals which will carry off the impounded water. For these operations junction piles or tees and steel tie rods at approximately 5ft. intervals. There are two rows of these tie rods, which stretch from channel walings on the face of the piling to anchor piles embedded in a concrete wall. The construction is illustrated in Fig. 1.

The piling was driven, the wall constructed and the tie rods fixed during the first low water season. It may be added that the water level in the river at the site of these wharves may vary by some 20ft. during the year. The filling behind the wall of piling was of sand from the river bed, deposited by a suction dredger. The wharves carry several broad-gauge railway tracks and materials are transferred from railway trucks to barges by steam locomotive cranes. What was a treacherous river bank of fine sand and silt, liable to be washed away during the floods or completely

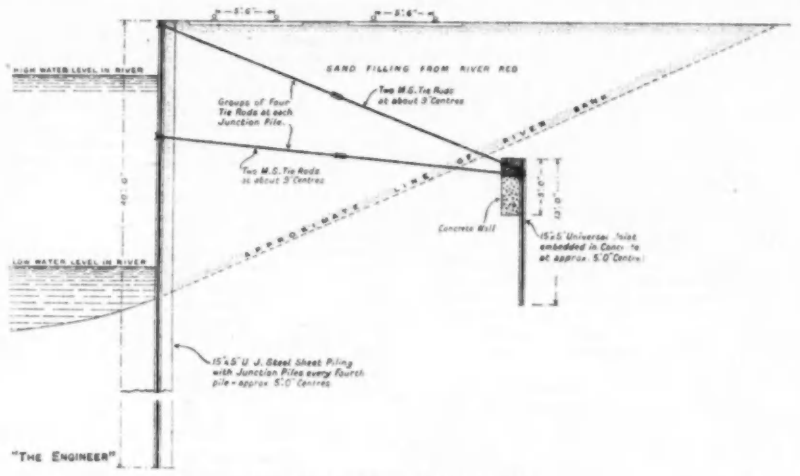

HIGH WATER LEVEL IN RIVER
SAND FILLING FROM RIVER BED
Groups of Four Tie Rods at each Junction Pile.
Two M.S. Tie Rods at about 5' Centres
RIVER BANK
Two M.S. Tie Rods at about 5' Centres
APPROXIMATE LINE OF
Concrete Wall
15"x5" Universal Joist embedded in Concrete at approx. 5'0" Centres
LOW WATER LEVEL IN RIVER
15"x5" U.J. Steel Sheet Piling with Junction Piles every fourth pile = approx. 5'0" Centres
"THE ENGINEER"

FIG. 1—SECTION OF WHARF WALL

altered by the deposits of the falling river, and was only used as a "resting place" or anchorage for the night by the country boats during their slow journey up to the Punjab, has been transformed in a short period into an up-to-date wharf where heavy loads can be efficiently handled during the whole year.

The most important temporary works in which the piling is being employed are the cofferdams in the river. These cofferdams enclose great areas of the river Indus, which are pumped dry and excavated to the required level for the masonry foundations of the regulators and barrage.

The arrangement of these cofferdams is shown diagrammatically in Figs. 2 and 3, the first of which is a plan while the other is a section. In Fig. 2 the relative extent mapped out for five successive working periods is indicated. During the first year's operations the wharves were constructed and the fifth period will witness the closing of the barrages. During the first four working periods operations will be carried out from both sides of the river simultaneously.

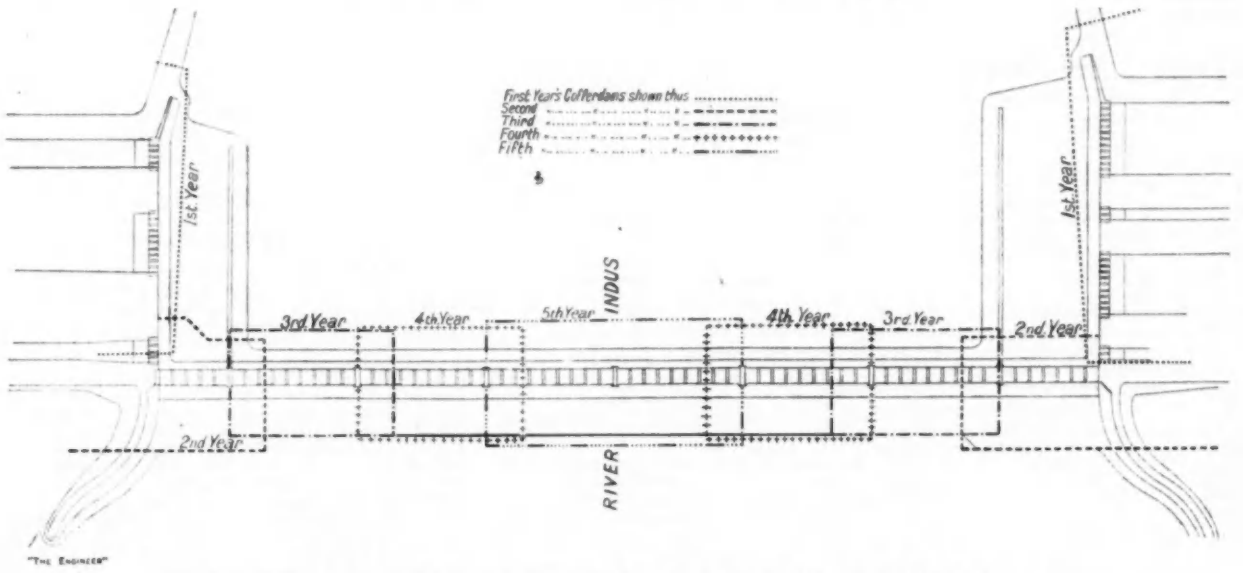


FIG. 2—DIAGRAMMATIC PLAN OF BARRAGE SHOWING ARRANGEMENT OF COFFERDAMS

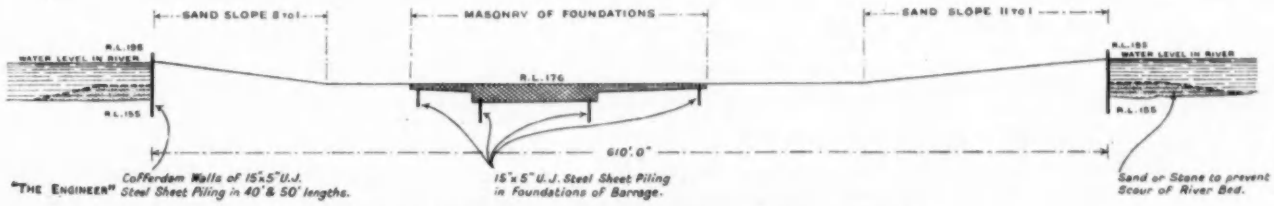

SAND SLOPE 8 to 1
MASONRY OF FOUNDATIONS
SAND SLOPE 11 to 1
R.L. 196
WATER LEVEL IN RIVER
R.L. 195
R.L. 176
610'.0"
R.L. 195
WATER LEVEL IN RIVER
R.L. 185
"THE ENGINEER"
Cofferdam Walls of 15"x5" U.J. Steel Sheet Piling in 40' & 50' lengths.
15"x 5" U. J. Steel Sheet Piling in Foundations of Barrage.
Sand or Stone to prevent Scour of River Bed.

FIG. 3—DIAGRAMMATIC CROSS SECTION OF BARRAGE SITE

Universal steel sheet piling, supplied by the British Steel Piling Company, Ltd., has been, and is still being used extensively in temporary as well as in permanent works.

In the first place, in order to facilitate the transport of materials from one side to the other of the river, which is about a mile broad at the site of the works, two riverside wharves were constructed. Each wharf consists of a wall of 15in. by 5in. Universal joist steel sheet piling, with

During the late summer and autumn the Indus is in flood, but about the end of September of each year pile driving can be started. The piles for these dams are 15in. by 5in. Universal joists, 40ft. to 50ft. long. They are driven by specially constructed floating pile-driving plants. Each plant consists of two standard 50ft. steel pile-driving frames, carrying a runway which provides a free travel of about 19ft. between the supports. Two McKiernan-Terry double-acting steam hammers, working in two sets of pendulum leaders, are suspended from a carriage travelling on the runway. By this arrangement it is possible to drive fifteen of the piles and clutches without moving the pontoon on which the plant is erected. All the plants have a 2-ton crane, with a 70ft. "cat-headed" jib for pitching the piles, which are brought alongside in barges.

A standard Zenith friction winch to deal with the hammers, one hammer on each drum, is fitted on the pontoon and steam for all the plant is supplied by two Spencer-Hopwood oil-fired boilers. The carriage carrying the pendulum leaders and hammers is operated by a hand winch and endless rope, and six hand winches are provided for manœuvring and anchoring the plant in strong currents. All this plant is accommodated on a pontoon measuring about 76ft. by 33ft.

The piling was driven into the river bed without the assistance of guide walings or timbering of any kind. Cofferdams, each covering an area of from about 22 to 14 acres, for the largest of which something like 3500 piles, weighing over 4000 tons, were driven, have already been constructed. Junction or tee piles were driven at intervals in the walls to stiffen them. The walls in some cases were about 1250ft. long. For the final season's work to complete the barrage, a cofferdam about 2300ft. long is proposed.

The river bed of the Indus is composed of very fine sand or silt, and scouring very soon takes place with any increase in velocity of flow. To protect the cofferdams from scour barge loads of large pitching stones are dumped against the piling—as shown in Fig. 3—or sand from the river bed is deposited by a suction dredger. In order to balance the pressures against the piling when the dam is dewatered, sand excavated by suction dredger from the barrange foundations inside the cofferdam is

deposited by the dredger, up to water level, against the cofferdam wall on the inside.

During the working season the water level in the river varies very considerably, as much as 20ft. "rise" having been recorded between the end of the year and the following August. To provide for the extra water pressure against the piling due to this "rise," sand from the excavations inside the dam is deposited against the piling and roughly dressed to a slope. This deposit increases daily as the work proceeds, the crest of the slope being kept approximately at the highest anticipated level of the water against the outside of the cofferdam wall.

On completion of the season's work the piling is extracted with the McKiernan-Terry hammers, with which it was driven, and a special extracting gear suspended from a 25-ton floating crane. The withdrawn piling is then reconditioned where necessary, and stacked ready for the next season's work.

In addition to the piling used for temporary work on this scheme, a certain amount of Universal joist piling is built into the permanent structures. Below the masonry of the floors of the head regulators and barrage, rows of sheet piling of 15in. by 5in. section, in lengths varying from 13ft. to 22ft., are driven into the bed of the river before any masonry is laid, the tops being left above the excavated level at a height sufficient to form a joint between masonry and piling. The top of the piling is embedded in concrete in the floor masonry to form a watertight joint between steel and masonry. This piling is driven in the dry, when the cofferdams have been dewatered, by the standard 50ft. pile-driving frames taken from the floating plants and mounted on standard undercarriages and travelling wheels, which had been supplied in readiness. The conversion from floating to land plant can be accomplished in a few days, and in this way all plants are kept busy during the comparatively short working season and the maximum amount of work is obtained from them.

The piling in the permanent work is used to provide a series of "bulkheads" or walls to reduce the effective head of water on the downstream side of the structures. Under the barrage and regulators there are four rows of this piling. An interesting point to note is that although the construction work is not continuous, but is carried out from both banks of the river, and is completed in sections —with several months' interval between the completion of one section and start of the next—there will be, when the whole work is finished four, rows of continuous piling from one bank of the river to the other, a distance of approximately 1 mile. Not only is the piling continuous across the river, but it is connected by means of the clutches to the piling in the permanent works of the head regulators, so that there may be no possibility of the water escaping by a "short cut."

The special floating units of pile drivers and crane were built by the British Steel Piling Company, Ltd. for the Bombay P.W.D., to the instructions of Mr. A. A. Musto, C.I.E., M. Inst. C.E., Superintending Engineer, Lloyd Barrage Circle, who designed the barrage and all the canals, and who is now constructing the barrage and the headworks of the canals. Mr. C. S. C. Harrison, C.I.E., is the Chief Engineer, Lloyd Barrage and Canals Construction, in charge of the whole scheme.

Letters to the Editor.

(We do not hold ourselves responsible for the opinions of our correspondents.)

GAS FOR INDUSTRY.

SIR,—I notice in your last issue, *a propos* of Sheffield a statement that the demand for gas for industrial purposes had been well maintained, but that until there was a definite improvement in trade rapid progress could not be expected.

Would not the development be more rapid in respect of the demand if we had really up-to-date legislation permitting the expansion of the gas industry without restriction? Electricity at the present time has a free hand; gas has not, and each party at the next election should be asked to pledge itself to introduce the necessary measure. It is a wonder that gas has done as well as it has under the circumstances, but we are very far from realising what it really can do if largely left to itself.

London, March 23rd. R. S. TIMPERLEY.

ROPE DRUMS.

SIR,—The interesting part of Mr. Barton's problem—page 330 of your issue of March 22nd—has been dealt with by many writers during the past fifty years in connection with the wire winding of gun tubes. But, having regard to the many unknown factors involved, *e.g.*, snatching and inertia, it is doubtful whether the application of wire winding theory to rope drums would be justifiable. The simple method of adding the effect of each coil is on the safe side. H. S. ROWELL.

London, March 23rd.

SIR,—*Re* the article which appeared in your issue last week on the above subject, the inquirer can obtain information from a paper on "The Rational Design of Hoisting Drums," by E. O. Watters, published in the "Transactions" of the American Society of Mechanical Engineers, 1920. The subject is also discussed in a book dealing with "Winding Engines and Winding Appliances," by McCulloch and Futters, published by Edward Arnold, London. CHARLES PATTERSON.

Edinburgh, March 25th.

South African Engineering Notes.

South African Cutlery.

FOR something like sixty years the mark "O I O" has been before the South African purchaser of an inexpensive pocket knife, designed for rough use on the farm and for the native trade. During that time the "O I O" knife has built up a sound reputation on the quality of its single blade, so that, to-day, most natives and many white country dwellers recognise the mark and appreciate the value of the knife bearing it. Three generations of proprietors have manufactured this knife in Sheffield, but recently they, finding that serious inroads were being made on their connection in this country by cheaper continental imitations, bearing other marks, took the decision to transfer their plant *en bloc* to South Africa and to manufacture on the spot. A plot on the Germiston Industrial site was secured and a factory erected, which has now been producing for some time. The steel for blades and springs is imported in sheets from Sheffield, and the handle is cast from Newcastle (Natal) pig iron melted in a pot furnace. The operators have been brought out, as well as the plant, and are satisfied with the iron, the only criticism by the firemen being with regard to the coke, which is rather dirtier out here than the fuel which they have been used to, so that fires require frequent cleaning, but, if that is attended to, the coke gives an excellent heat. The Germiston knife is turning out to be as good as the Sheffield product, as was to be expected, since, as far as the steel is concerned, the only thing which has been changed is the site of the factory. This is an entirely new industry in this country, and the firm's enterprise is commendable. Although the pocket knife is so far the only product, blanks of rustless steel are already in hand for the manufacture of a cheap rustless table knife, which should secure a wide use as soon as it is put on the South African market.

Peat Finds at Durban.

After several weeks of prospecting and exhaustive tests on behalf of a well-known Durban firm, it has been discovered that the swamp on the bluff, between King's Rest and the sea, is composed of peat rich in tars, oils, and other substances, which will be commercially workable. The discovery of the wealth of peat accounts for old stories told by natives, and believed by many Europeans, that the swamp lies in the crater of an extinct volcano. The presence of gases first attracted expert attention to the swamp, and explorations have been carried out during the past few weeks by means of drill holes, and the analysis and distillation of actual samples. Several of the boreholes have been sunk to a depth of 30ft. and more. The official report is that extensive deposits offering commercial and industrial possibilities have been found.

Road Motor Services.

The route mileage of the S. A. R. road motor services is expected to exceed the open mileage of the railways before the end of the year. Already over 9000 miles of services are in operation, as against 12,648 miles of railway. Some of the routes are very long, for example, Breyten–Gollel, 224 miles; Potgietersrust–Tomburke, 174 miles; and Bitterfontein–Springbok, 116 miles. The policy of expanding these services undoubtedly means that the country is being saved the construction of many unpayable branch lines. Johannesburg is putting on its streets a further fifteen motor omnibuses. The body work is local, and is mounted on a Leyland Lion chassis. The vehicle weighs some 4 tons 15 cwt., and it is capable of attaining a speed of 40 miles per hour. The city now has thirty-five new omnibuses on the road, in addition to a number of second-hand vehicles taken over. Johannesburg is, however, considerably behind Cape Town in respect of omnibuses, the latter city having over 200 now running, and the number is being added to every month.

Transvaal Mining Developments.

At a recent meeting at Johannesburg of the Chemical, Metallurgical and Mining Society, Mr. E. R. Scoch read a paper dealing with the future of the mining industry. It was entitled "Notes on the Nickel and Copper Deposits of the Norite Complex West of the Pilansberg, in the Rustenburg District," and it gave for the first time authoritative details of the development of this most interesting discovery. The area over which these deposits have been followed covers a distance of approximately 16 miles. Though in places cut off by faults, the vertical continuity of the ore bodies is remarkable. Another noteworthy feature to which attention was drawn was the comparatively uniform distribution of the nickel contents of the ore bodies. The same remark does not apply to the copper contents which fluctuate within wider limits. This consistency augurs well for the development at greater depth. Mr. Scoch concluded with the remarks:—"The development down to a depth of 350ft. vertically—at which depth no visible alteration in behaviour is noticeable—has proved them to be no mere surface deposits. They appear to have a deep-seated origin, and it is also reasonable to suppose, judging from the consistent nickel values obtained right down to the lowest point, that the metal content will show similar results at depth. The developments to date have also proved that whereas the deposits are not very large individually, they are of sufficient size and quantity to constitute a sound mining proposition, and that there is here the nucleus for a local mining industry which may eventually produce enough of that metal to satisfy the requirements of this country, and leave a handsome margin for export purposes."

State Railway Workshops.

The Government's policy of erecting points and crossings workshops at Bloemfontein instead of at Pretoria is severely criticised in Rand business circles, as an offer made by a British industrial group, represented by Mr. F. C. Sturrock, of Johannesburg, to manufacture points, crossings, and other railway material from raw Union steel at Pretoria and to provide a capital sum of £300,000 if necessary, has been declined by the Government on the ground that the points and crossings factory could not be separated from the larger one of the central railway workshops, and it was therefore decided to start a State factory on a total allocation of £75,000.

During the course of the negotiations Mr. Sturrock is said to have pointed out that not only would it be possible at the factory his principals proposed to erect, to manufacture, from Union steel products, the points and crossings required for the South African Railways, but it would also be possible to expand the industry to manufacture, say, steel sleepers and other railway requirements, which a private company would be able to sell to neighbouring Governments, such as Rhodesia. If, however, the workshop remained in the hands of the Union Government—indeed were a purely Government concern—the Government would be debarred from selling to a neighbouring Government, or from competition with private firms, as sentiment and precedent would be both against it. Mr. Sturrock also seems to have contended that a points and crossings factory ought always, as a matter of principle, to be stationed near a raw steel factory, that is to say, in the present case, in Pretoria, for the reasons that railway transport and handling charges would be minimised, and that it would in every way make for greater efficiency and convenience.

THE INSTITUTION OF WATER ENGINEERS.

THE thirty-fourth summer general meeting of the Institution of Water Engineers will be held at Birmingham on Wednesday, Thursday and Friday, May 22nd, 23rd and 24th next. By permission of the Lord Mayor and Corporation, the meetings will be held in the Council Chamber at the Council House. The following programme has been arranged:—

On Wednesday, May 22nd, at 10.30 a.m., an official welcome on behalf of the City of Birmingham will be extended to the Institution by the Lord Mayor—Alderman W. Byng Kenrick—and the chairman of the Water Committee—Alderman Colonel E. Martineau. The chair will then be taken by the retiring president, Mr. Samuel Christopher Chapman, M. Inst. C.E., and after the presentation of premiums awarded by the Council for papers presented during 1928, the new President, Mr. Frederic William Macaulay, M. Inst. C.E., chief engineer, City of Birmingham Water Department, will be installed and give an address. Two papers:—(1) "Birmingham Waterworks—More Recent Developments," by Mr. J. W. Wilkinson, M. Inst. C.E.; and (2) "Wenallt Reservoir, Cardiff. Special Construction Works," by Mr. G. W. Cover, A.M. Inst. C.E., will then be read and discussed. The programme for the afternoon will comprise the discussion of two lectures and the execution of any other business. The lectures, which will be taken as read, are as follows:—(1) "Some Remarks on the Geology of the Elan Valley," by Herbert Lapworth, D.Sc., M. Inst. C.E.; and (2) "The Construction of the Shavers End Reinforced Concrete Service Reservoir, Dudley, belonging to the South Staffordshire Waterworks Company," by R. A. Robertson, A.M. Inst. C.E., chief civil engineering assistant to Mr. Fred. J. Dixon, M. Inst. C.E.

The thirteenth annual dinner of the Institution will be held at the Grand Hotel, Birmingham, in the evening, at 7 for 7.15 p.m.

For the Thursday a visit to the following has been arranged:—Elan Aqueduct—Birmingham Corporation—Prestwood Pumping Station—South Staffordshire Waterworks Company—Bartley Reservoir and Frankley Works—Birmingham Corporation. In the evening, from 8 to 10.30, a reception will be held at the Council House by the Lord Mayor of Birmingham.

On the Friday a whole day's visit will be paid to the Elan Valley Waterworks of the Birmingham Corporation.

RAILWAY SIGNALLING AT MANCHESTER.

IT is well known that the Westinghouse Brake and Saxby Signal Company, Ltd., was responsible for the installation of the new power signalling at Victoria and Exchange Stations, Manchester. The company therefore takes considerable interest in any press notices with regard to that installation, and we have to thank it for the following explanation of the delays which occurred recently and attracted some attention in the Press. We may mention that this new power signalling installation is nearly, if not quite, as large as the installation just made at London Bridge, and the traffic at Manchester is probably as dense a steam-operated line as that in any part of the kingdom.

"In order to make the changeover from the old to the new signalling with the least possible disturbance to traffic, it was arranged that the operations should be divided into first, second and third. The first operation, *i.e.*, the bringing into use of signalling on the old Lancashire and Yorkshire lines, took place on the night of March 9th–10th. All apparatus operated satisfactorily, except for a few minor delays. On the Monday morning unfortunately, coincident with very heavy fog, there were a few pairs of points which threw correctly, but which, owing to frost and ice, worked rather stiffly and consequently indication was not always immediately received. In addition, the difficulty of trains being late was accentuated by signalmen having to use new signal apparatus, while drivers were not familiar with the new signals. The morning delays were cleared up by noon, and trains were practically on time in the evening rush hours. Since this time, there have been no delays on the L. and Y. side.

"On the night of March 16th–17th the new signalling was brought into use on the old L. and N.-W. lines in and out of Exchange Station. This worked very satisfactorily on Sunday, and despite the fog on Monday morning. Unfortunately the evening fog and the dense traffic led to some misunderstandings on the part of drivers, shunters, and signalmen, and you will probably appreciate, with your undoubted knowledge of railway operating conditions, that once the traffic has been upset in fog, it is very difficult to recover, and that in fact the delays are likely to be cumulative." We are informed that since Monday night, March 18th, the delays have disappeared, and that on this, the second operation, the traffic is now being operated as well as on the first.

Railway and Road Matters.

THE coroner's inquest into the death of the guard and fireman killed in the collision of March 9th at Darlington was resumed and concluded on March 20th. No explanation was forthcoming as to why the light engine was on the main line, so the jury returned a verdict of accidental death, and said that no one was to blame.

THE more serious accidents to railway servants, inquired into by the assistant inspecting officers of the Ministry of Transport during the three months ended June 30th, 1928, numbered forty, of which eighteen were fatal cases. Of the latter, eight of the sufferers were permanent way men. The causes assigned in the eighteen cases were:—Misadventure, nine; want of care, seven; no look-out man, one; failure of mechanism of a capstan, one.

IN steam locomotive rating, said Mr. T. Grime, at the Junior Institution of Engineers, the usual basis on which mean effective pressures for varying speeds of locomotives was calculated, was that of piston speeds, but it was his opinion that revolutions per minute constituted a better basis, as, for any given speed in revolutions per minute, the period of valve opening at constant cut-off for admission and exhaust, would be the same independently of the stroke, and if the steam and exhaust ports were proportioned on the basis of piston swept volume, as they should be, then the influence of piston speed *per se* could be neglected.

IN this column of our issue of January 25th extracts were given from a paper read on January 8th at the Newcastle and Sunderland Railway Lecture and Debating Society, wherein it was stated that, as a result of the use of a "Sentinel" shunting engine by the London and North-Eastern to shunt wagons into station order in anticipation of the arrival of the pick-up freight train, it had been possible to rearrange the steam engine workings so that two only were required instead of three. It was added that the economies in working costs were expected to be sufficient to pay for the "Sentinel" engine in two years. A sequel to these results would appear to be found in the recent statement that the London and North-Eastern Railway has now ordered eighteen similar engines.

THE question of insufficient charges of gunpowder in fog-signals, mentioned by Lieut.-Colonel Mount in his report on the Dinwoodie accident, where apparently the four enginemen of the express did not hear the explosion of the two detonators laid by the guard of the freight train, has been alluded to in accident reports on two previous occasions. The first was when, after a severe snowstorm on December 19th, 1916, the down "postal," drawn by two engines, exploded four fog-signals which were not heard on the footplate. Colonel Pringle then observed that such a possibility, in any circumstances, had never, to his knowledge, been mentioned in the past. The second case occurred on February 3rd, 1921, at Queen's-road, near Waterloo, where a driver did not hear a single detonator. Apparently after the latter collision the railway companies considered the question, and a new specification was agreed to. One company—the Great Western we believe—made its requirements higher still, and now Colonel Mount recommends that in view of the circumstances at Dinwoodie the matter be given further consideration, having regard to the double-heading of trains.

THE serious financial condition of British railways last year was reflected in their capital expenditure. When their annual reports for 1927 appeared first, over a year ago, the four grouped companies budgeted a capital expenditure of £4,269,700 on new works, but they spent only £2,344,709, and whilst they proposed to expend £946,000 on rolling-stock, the amount spent was only £451,302. Other branches brought the proposed expenditure up to £7,061,400, but the amount expended was only £3,621,454. The London, Midland and Scottish, for instance, spent £130,000 less than was intended on additional station accommodation, £200,000 less on widenings, £120,000 less on enlarged engine sheds. Instead of devoting £654,000 to carriage and wagons, the expense incurred was only £7500. On the other hand, £99,518 was devoted to locomotives instead of the proposed £12,000. The outstanding variation on the London and North-Eastern was the capital charge of £126,434 for road motor vehicles instead of £10,100. The Great Western saved £100,000 generally. The Southern budgeted £860,000 for the electrification of suburban lines, but spent only £8900 out of capital; £188,144 was incurred on widenings instead of the proposed £482,000, and £106,000 on the electrical equipment of trains instead of £280,000.

THE series of mishaps that occurred outside London Bridge Station on December 27th last, as related in this column on January 11th, were inquired into by Colonel Trench, whose report thereon has just been issued. The initial incident was that a steam-worked train from New Cross to London Bridge over-ran the home signal for the up through line and collided with an arriving passenger train which was crossing from the adjoining up local on to the down through line. Three vehicles on the latter train were derailed, and one of them displaced a girder that used to carry the catenary wires of the now discarded alternating-current electric traction. The girder fouled the up South London line, and was struck by a train arriving on that line, which caused it to fall on to a train departing on the down South London. Thanks largely to the prompt action of the various members of the railway staff concerned—particularly, it seems to us, the guard of the train that was crossing, who noticed that the steam train was still travelling forward—none of the succession of accidents was serious nor were there any personal injuries to passengers or staff. Colonel Trench concludes his report by recommending automatic train control, giving a full brake application at the stop signal, and says that, in principle, this accident provides a strong case in favour of such control in congested areas with dense traffic. After observing that the colour light signalling provided at London Bridge gives particularly conspicuous and arresting indications, he states that if a driver carelessly permits himself to misread such indications, owing to momentary mental aberration, it seems difficult to provide against failure of the human element other than by automatic means.

Notes and Memoranda.

DURING a single shift of eight hours 17,263 tons of coal were recently shipped from the tips at Alexandra Dock, Newport. The previous best record was 15,753 tons.

A PLANT for creosoting timber, which is to cost 500,000 dollars, is to be erected at Vancouver. In this connection it is stated that the use of treated timber is rapidly growing in favour in Canada.

THE new steam power plant which is to be put up at San Francisco by the Pacific Gas and Electric Company is to be of 300,000 horse-power and the first two units to be installed will be of 70,000 horse-power each.

AN office building is being constructed in Minneapolis which has thirty-three storeys, is 450ft. high, and has a base of only 89ft. by 87ft. The exterior walls have a batter, so that the dimensions at the top are 58ft. 2in. by 54ft.

THE Ambassador Bridge, which is to connect Canada and the United States, between Windsor and Detroit, is to be equipped with neon tube sign lights, with the object of guiding travellers towards the crossing. The signs will be 6ft. tall and will be fixed on the top of the 400ft. towers of the bridge.

THE total capacity in water power plants of the United States was 12,571,530 horse-power on January 1st, 1929, This represents an increase of 10·4 per cent. during the year 1928. Each of the two preceding years had shown only 4·9 per cent., but there had been more than 10 per cent. increase in both 1925 and 1924.

INVESTIGATIONS by the Department of Scientific and Industrial Research have been proceeding at the Building Research Station for some time into the causes of failure experienced with breeze and clinker concretes. The object is to evolve simple methods to enable their soundness to be tested, and a description of the proposed tests is given in Building Research Bulletin No. 5. (H.M. Stationery Office, price 6d. net.)

THE rivers of Pennsylvania have, of course, been dredged for coal, washed down from the mines, for many years, and the result has been a popular coal of the size of about buckwheat. Now arrangements are being made in Germany for dredging "mud" from the bed of the river Emscher, which is said to have such a calorific value that it will justify the construction of an electric power station. As much as 100,000 tons of fuel is to be produced a year. This river receives the washings from the Westphalian coalfields.

THE coking power of coal is being studied by the Department of Commerce at the Pittsburg and Seattle experiment stations of the United States Bureau of Mines. At Pittsburg the coking constituents are extracted by benzene under pressure and their properties are studied. At Seattle the strength of cokes produced from different coals under standard conditions is being measured. Recent results of this work indicate strongly that it is the high-melting bitumens, solid at room temperature, which contribute most to the strength of coke produced from a coal.

AN explosion of a rather unusual character is recorded in one of the most recent Board of Trade reports, and it emphasises the necessity for all plant to be made as "foolproof" as possible. A centrifugal pump, with 2in. branches, was used for handling soap lye. In the event of the lye becoming too viscous to be pumped high-pressure steam could be turned into the suction pipe. Such a procedure was adopted on one occasion, and the pump casing blew up, injuring the attendant. It should have been obvious that if the piping was choked the admission of steam to the pump should be carried out with the greatest circumspection.

ASPHALT grouting is being used in the sinking of a 20ft. salt mine shaft through water-bearing gypsum to a depth of about 250ft. into a salt dome near Houston, Tex., for the Texas Salt Company. The shaft is fully lined with concrete. In the early stages of the sinking cement grouting was, according to the *Engineering News-Record*, depended upon to seal the fissures in the rock and keep out the water carried in them at high pressure. On several occasions the shaft was lost, and was regained only after sealing with a concrete plug. Grouting with asphalt is now being done about 20ft. in advance of the shaft bottom. In sealing the seam between the gypsum rock and the top of the salt, pressures up to 2000 lb. per square inch are being used.

IT is reported from the United States that the General Super Diesel Motors Corporation has announced that it will produce in the near future an eight-cylinder, air-cooled, hot-air injection aeroplane engine, using fuel oil instead of petrol. The company states that this newly-patented machine, which is of the radial type, will eliminate all valves now used in four-cycle machines, as well as sparking plugs and carburetters. The cylinders are 5in. by 6¼in., and at 1500 revolutions a minute each cylinder will, it is stated, develop 40 horse-power, or a total of 320 horse-power for the eight cylinders. The new engine is supercharged under control of the operator to meet high altitude conditions. It weighs about 1000 lb., but that weight can be reduced substantially by the use of special material.

WHEN a cartridge of dynamite is separated from another by an air gap and detonation is initiated in the first cartridge, the second cartridge is caused to explode by influence, providing the gap is not too great, and the second cartridge is sufficiently sensitive. It is the nature of this "influence" which is being investigated in America by pressure wave photography. The photographs show that the first cartridge sends out pressure waves which beat against the second cartridge and that an instant later the expanding gases from the explosion strike the second cartridge. Sensitive explosives may be detonated by the pressure waves, while less sensitive explosives do not detonate until struck by the body of hot expanding gases. The method will be used also to investigate the mechanism of the ignition of fire-damp air mixtures by the explosives used for blasting in coal mines, where it is believed that adiabatic compression of the inflammable mixture may play a part in causing explosions.

Miscellanea.

IT is proposed to start a beet sugar industry in Persia.

A WATER supply scheme, to cost £10,000, is being considered by the municipality of Maclear, South Africa.

A TUBE-MAKING plant, with a capacity of 100,000 tons a year, is being put up in Poland by the Bismarkhutte.

A SCHEME of railway construction totalling nearly ten thousand miles of line has been formulated by the Chinese Minister of Railways.

THE Norwegian Edwin process for the production of sponge iron is to be worked by a new German plant, which is starting operations in April.

THE net revenue of the working of the Bengal forests during last year was 16·47 lakhs of rupees, as compared with 3·6 lakhs some forty years ago.

THREE new piers are being built in Montreal. These, together with other improvements, are to cost 10,000,000 dollars. The work is to be finished by 1930.

IT is said, in the *Ironmonger*, that a bed of sand, claimed to be one of the best in the world for foundry purposes, has been discovered at Preesall, near Blackpool.

A BATTERY of sixteen 62in. gas retorts is to be installed at Rugby by the Woodhall-Duckham Company. The plant will be capable of carbonising 93 tons of coal a day.

THE arsenal at Mukden is, according to the *Ironmonger*, in the course of being transformed into a large motor factory. Agricultural machinery is also being made at the hospital.

ANOTHER natural gas well has been "brought in" in the Turner Valley of Alberta. It yields about 22 million cubic feet of gas a day and from this 600 barrels of naphtha are produced daily.

THE two new coastal steamers of the Canadian Pacific Railway, which are to be built on the Clyde, are to be of 5000 tons each, with accommodation for 430 passengers. They will be 365ft. long.

SEVERAL bridge building schemes are projected in the Kimberley district of South Africa. They include two across the Vaal River at a cost of £6500 and £20,000 respectively, and another across the Riet River, to cost £1500.

IN its first six months of operation the Great Western Airways, Ltd., of Canada, carried 1608 passengers 82,906 miles; explored 2200 square miles from the air; photographed 600 square miles; and gave flying instructions to 38 students.

A PLANT for the production of steel from scrap iron is to be put up near Vancouver. Electric power is to be used for melting purposes and an output of 20,000 tons a year is intended. It is said that there is ample scrap in the country to provide for this output.

EXPERIMENTS are being carried out by the Grangesberg Company, at its mines in Central Sweden, on the use of higher pressures than usual for the operation of pneumatic drills. It has already been found that doubling the air pressure will increase the drilling speed twofold.

AFTER extensive investigation by a Nova Scotia firm, machinery has been devised for the quilting of the "eel grass" found on the sea shores of that country, to form a building material resistant to both heat and sound. A factory for the manufacture of such a product has been organised.

THE Government of Bulgaria is inviting tenders, closing upon April 26th, for large quantities of railway material. Quotations must be c.i.f. Varna or Danube ports, with delivery this year. Passenger cars to the number of 179 are asked for, as well as several hundreds of goods trucks and locomotives.

A HYDRAULIC pressure test was made by the Sheffield Testing Works, Ltd., of a fitting, described as 1in. Wask banded elbow, submitted on February 14th, 1929, by Walter Slingsby and Co., Ltd., of Keighley. The elbow is of malleable iron, 1in. size, 1·57in. diameter outside. It showed no signs of leakage until a pressure of 8940 lb. per square inch was reached. At this pressure water commenced to spray from the fillets at the bands. The pressure was increased to 9250 lb. per square inch, but complete rupture of the fitting did not take place.

AN anonymous donor has, says the *Ironmonger*, presented a sum of money to the Institute of British Foundrymen, the interest of which will be used each year to provide silver medals to be known as the Robert Buchanan Memorial Medals. One medal will be offered each year to each Junior Section of the Institute for competition among its members. The award will be made on the result of an essay giving a *réaumé* on the session's work of the particular junior section to which the candidate is attached. Robert Buchanan was one of the founders of the Institute.

ENORMOUS coal deposits are said to have been discovered near the Tiger Hill, north-west of San Cha Ko, Ningan Hsien, Kirin province of Northern China. The discovery was made by four British travelling engineers. The thickness of the coal bed is over 12ft. Although the exact amount of coal deposits is unknown, an estimate has it that the supply of the mine will not be exhausted in sixty to seventy years. Together with the coalfield, an oil well has also been discovered. A chemical analysis gives the quality of both the coal and the oil as being very satisfactory.

THE motor lifeboat which the Royal National Lifeboat Institution has built for Courtmacsherry, Co. Cork, has done a record run, for lifeboats of her type, in her journey from the building yard at Cowes to her station. She is of the Watson cabin type, 45ft. 6in. long, with two 40 horse-power engines. She did the journey of 358 miles in just over forty-nine hours, calling at Torbay, Penzance, and St. Mary's, Isles of Scilly. The final run from St. Mary's to Courtmacsherry was straight across the St. George's Channel, and the distance was 139 miles. It took twenty hours, giving an average speed of 7 knots, only 1 knot less than the boat's highest speed on trials. This is the longest run ever done by a motor lifeboat of the Watson cabin type.

THE LONDON POWER COMPANY—DEPTFORD STATION

(*For description see page* 342)

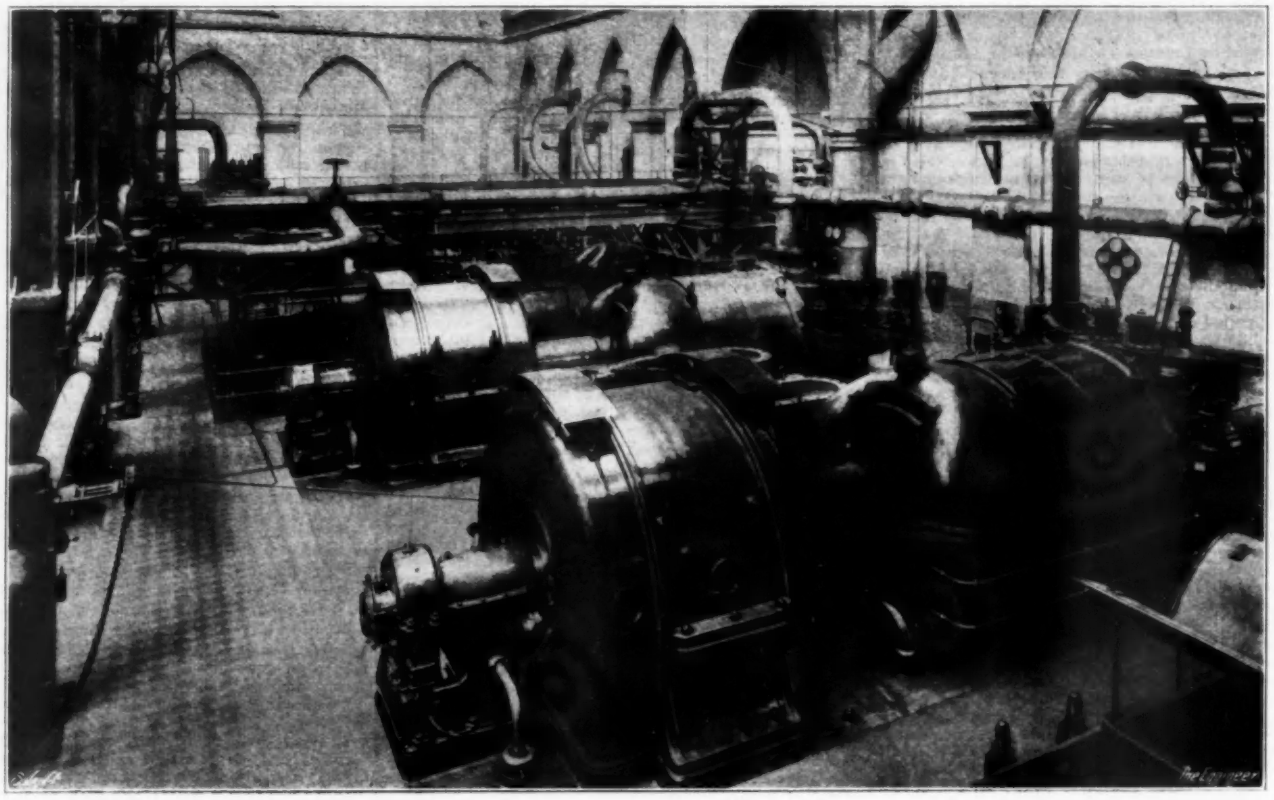


FIG. 33—DEPTFORD EAST—PART OF TURBINE-ROOM

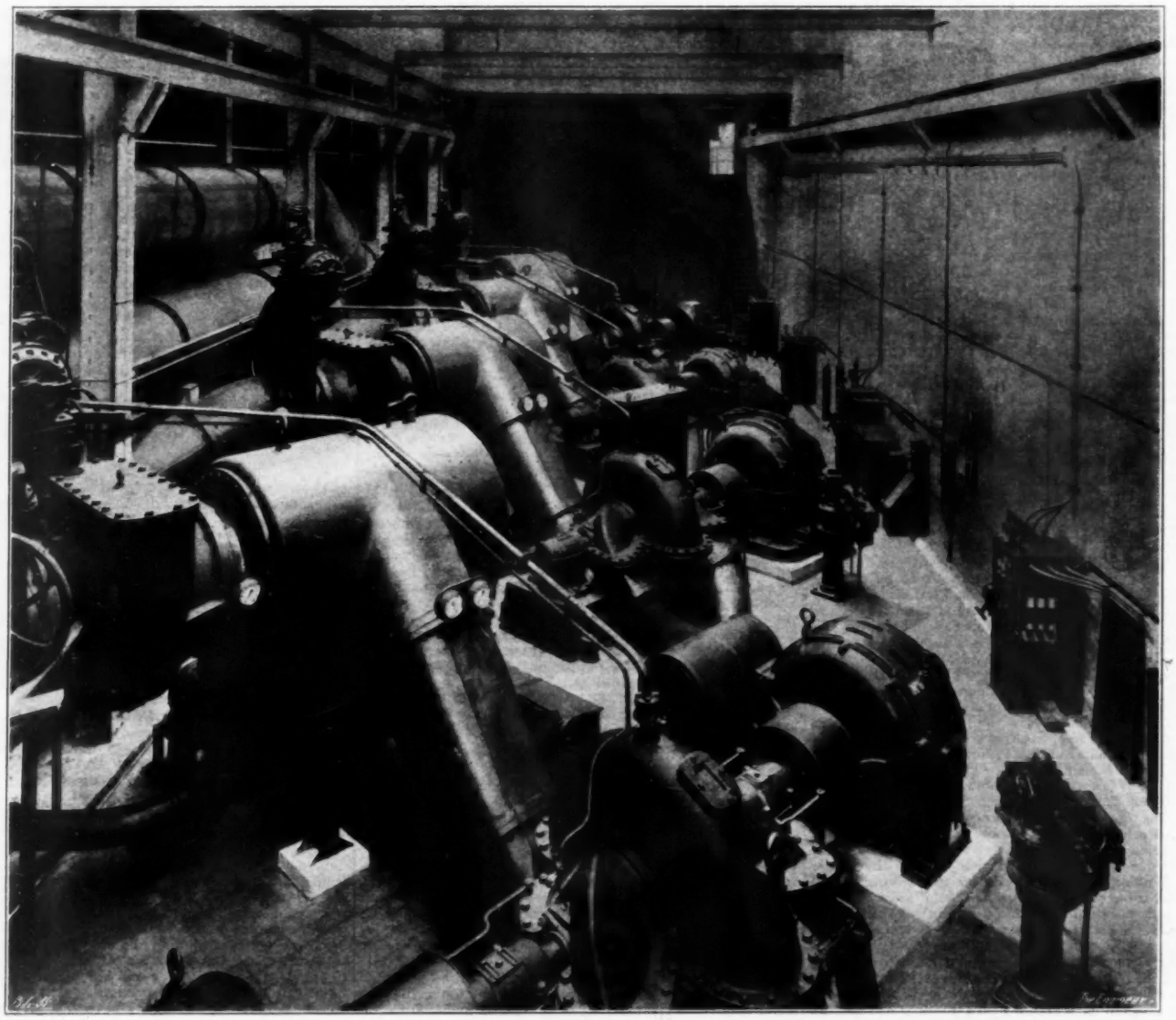


FIG. 34—DEPTFORD EAST—CIRCULATING WATER PUMPS

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The Metallurgist.

THE MARCH NUMBER OF THE MONTHLY METALLURGICAL SUPPLEMENT TO "THE ENGINEER" ACCOMPANIES THIS ISSUE.

THE ENGINEER.

MARCH 29, 1929.

Recent Advances in Marine Propulsion.

A NEW and welcome feature of the Spring Meetings of the Institution of Naval Architects, the account of which is continued elsewhere in our present issue, was the inclusion in the programme of two papers by marine superintendent engineers, in which typical examples of modern steam propelling machinery were described. We refer principally to the very full and able account given by Mr. John Johnson, which we reprint almost in full on another page, of the development of the high-pressure geared turbine system of propulsion in successive ships of the Canadian Pacific Railway Company's Atlantic and Pacific fleets. The other shorter paper was that presented by Mr. C. F. A. Fyfe, which dealt with a combined reciprocating engine and exhaust steam turbine installation on a Booth liner. The co-operation of the shipowner with his technical adviser, which enables actual service performances, with guiding figures relative to both capital and running costs and machinery weights to be put forward for discussion, is to be warmly commended. When, as at the present time, shipbuilders and marine engineers are called upon to develop different types of propelling machinery, and the shipowner when ordering new tonnage is confronted with almost a bewildering choice of alternatives, it would simplify greatly the task of choosing the most successful ship for a given trade route if more information such as that given by Mr. Johnson were available for other types of ships and engines.

The case for high-pressure and high-temperature geared turbines supplied with steam by water-tube boilers had already been well prepared by the earlier and more academic papers given by Sir John Biles four years ago, and it must have given considerable satisfaction to Sir John and his friends who are championing the cause of high-pressure steam, to see how many of the advantages claimed have been substantiated in the C.P.R. steamers. Much credit is due to Mr. Johnson for the way in which he has attacked the condenser problem, and overcome the question of pure feed, by the simple expedient of adopting a combined system of water-tube and Scotch boilers. The paper shows that excellent results have been obtained in his new oil-fired "Duchess" class liners and the coal-fired cargo steamers of the "Beaver" class, while even better efficiencies are awaited from the new "Empress" class of liners now under construction on the Clyde. So confident is Mr. Johnson of the advantages conferred by high-pressure steam propulsion, that he looks forward to obtaining fuel rates of the order of 0·5 lb. of oil for propulsion only and 0·55 lb. for all purposes in the higher powered installation, which will assure, he suggests, a predominant position for high-pressure steam propulsion, even if powers and speeds are still increased. With the experience already gained, there is no doubt that such results will be attained. But we are certain that equally good—possibly even better—figures could be put forward by the advocates of the motor vessel. One object of Mr. Johnson's paper is to compare relative costs of steam and internal combustion installations for ships of passenger and cargo types, and with that purpose in view, he gives figures for the estimated capital costs of the two types of vessels. In each case the cost of the motor ship is higher than that of the steamer, and it is then argued that the annual charge on the extra first cost of the motor ship would be more than sufficient to defray the entire cost of repairs for the steam installation. The case for the motor vessel is further weakened by what are referred to as indeterminate repair charges and heavy consumption of lubricating oil. It is much to be regretted that, with the exception of Mr. Sterry B. Freeman, who criticised the prices put forward for steam and motor ships and referred to the question of vacuum and its effect on efficiency, no reply was forthcoming from those who hold that the most economical place to burn the fuel is in the cylinder of an internal combustion engine. It would have been very interesting if figures similar to those given for the C.P.R. vessels could have been put forward for the Swedish-American motor liner "Kungsholm," which entered service early in the year and is operating on the North Atlantic route. That liner has a tonnage comparable with that of the "Duchess" class liners, although her dimensions are slightly larger. From the performance results of the recent voyages it appears that for a speed of 18·3 knots only 14,500 S.H.P. is required from the twin-screw double-acting four-cycle machinery, which corresponds to 63·6 tons of oil fuel per day for propulsion alone, or about 0·406 lb. per S.H.P. hour. It is understood that the motor liner will, having no boilers to clean, remain at sea considerably more than 200 days in the year. Now that the case for high-pressure steam has been placed on a practical basis by the publication of actual performance figures, it is, in the interests of marine engineering progress, highly desirable that similar figures should be given for oil-engined vessels. There has been in the past a noticeable reluctance on the part of both owners and builders to give this very necessary information, without which a real discussion of the problems involved is made very difficult. Much work has been done in developing the British marine oil engine, and we cannot think that either in the matter of capital and running costs, or the equally important question of reliability and maintenance charges, the modern marine oil engine falls behind up-to-date steam plant in these respects. The whole field of advance in marine propulsion is a very wide one, but it is now apparent that definite progress is being made on the steam side. As foreshadowed in Admiral Scott Hill's paper, there seems to be a possibility of designing ships to utilise either oil or powdered fuel, as prices may dictate, while for the smaller vessels undoubtedly economies are being introduced by exhaust turbine installations and improved forms of valve gears for reciprocating engines. On the oil engine side a successful effort has been made to reduce by standardised production the first cost of the oil engine, and there should not now be that difference in price between a steamer and motor vessel which was usual a few years ago. In many ships a trunk type of oil engine operating at a comparatively high speed is being utilised, which introduces new economies, both on first cost and the space taken up. The new Belfast–Liverpool cross-Channel motor ships are being fitted with this type of engine, and actual results should be available during the year.

We note with interest that the Summer Meeting of the Institution of Naval Architects is to be held in

Italy. The shipowners and marine engineers of that country have done important work in the construction and operation of large passenger ships, both of the steam-driven and the oil engine driven types, in which work British firms and British marine engineers and naval architects have co-operated. We would put forward the suggestion that at the Italian meetings, at which, we believe, it is proposed to discuss the trials and performances of the "Viceroy of India," an effort should be made to secure the consent of the owners of steamers and motor vessels operating in the North and South American trades to publish figures regarding the comparative performances of similar steamers and motor vessels. In particular, attention might be paid to the very successful refrigerated cargo ships of the Nelson and Houlder lines, figures for which ships might be compared with interest with those of the Blue Star Line, using hand-fired and also powdered coal. The extreme reticence of motor ship owners to publish actual performances and to give correct figures with regard to running and maintenance charges, is detrimental to the best interests of marine engineering progress, and we express the hope that some means may be found to overcome this hesitancy.

Weight-saving.

The specialist is a man with a microscope. The more closely he specialises the more must he reduce his field of vision. Moving ever towards the use of more and more powerful objectives, a time is at length reached when he can see nothing but the minutiæ of the subject in which he is interested and has become blind not only to matters outside his limited field, but even to the larger issues within it. In engineering that is a perpetual danger. Each new branch becomes so large in itself that it surpasses the capacity of a single man to encompass it all. Specialisation up to a point is essential; but even the specialist, if he is wise, makes occasional excursions into other fields. In them he finds not infrequently something of value to him in his own work. His imagination, too, is stirred, and even if he cannot apply directly the inventions and developments which he has seen, he may be inspired to follow new steps of progress of a similar order in his own domain. We may see in the greater engineering societies a recognition of the necessity of preserving broadness of vision. The Institution of Mechanical Engineers is notable in that respect. It covers all branches of mechanical engineering and even touches upon metallurgy. There are a few technical newspapers in the world—they can be numbered on the fingers of one hand—which go even further and present to their readers a conspectus of the progress of *all* branches of engineering and the sciences allied to them. Their task is a difficult one, but we may express a hope that it may never become impossible. In an age of specialisation it is of the greatest importance that a wide field of vision should be available as a corrective to over-concentration.

On Monday, March 25th, Wing-Commander Cave-Brown-Cave delivered the annual lecture to the graduates of the Institution of Mechanical Engineers. It was an excellent discourse. The title was the "Relationship of Aeronautical Engineering to Mechanical Engineering." The author showed by an examination of the details of a "Lion" engine and by other subjects how the aeronautical engineer impelled thereto by weight restrictions, had developed special methods of assembling parts, special designs of details, and the employment of special metals. What had proved sound mechanical engineering in aeronautical work ought to be equally sound in work built under less exacting conditions. Let us take a single example. There is an aeronautical engine which weighs 8 lb. per horse-power. It was designed by engineers on conventional lines. Weight was economised as much as possible, but none of the devices which the specially trained designer of aeronautical engines has developed were employed. If that engine were redesigned by an aeronautical engineer, the lecturer was certain that its weight could be reduced to 2 lb. per horse-power. Even allowing something for the confidence of the specialist, it is clear that the ordinary mechanical engineer has not a little to learn about weight-saving from the aeronautical engineer. At one time very little attention was paid to that subject; it was not easy to estimate its value. Cast iron was cheap and "massiveness" was regarded as a noble quality becoming in the products of John Bull. Then the age of the bicycle came in, and the search for lightness began; the motor car followed, and was succeeded by the aeroplane and airship, in which economy of weight is essential. Massiveness is no longer a merit. We want nowadays the qualities that massiveness imparts, but we want them with lightness of structure. The engineer has to follow his great predecessor, the Gothic builder, and forget his admiration of the colossal products of the Normans and Egyptians, which depended for their stability on mere mass. An admirable example is presented by the problems of warship design, which have been imposed upon naval architects and engineers by the Washington agreement. Take the case of the battleships "Nelson" and "Rodney," which were admirably described by Sir William Berry and Sir Eustace d'Eyncourt at the recent meeting of the Institution of Naval Architects—see The Engineer, March 22nd. Their weight was limited to 35,000 tons, but they had to carry nine 16in. guns in triple turrets, and it was decided that an armoured deck no less than 6½in. in thickness was essential as protection against plunging gun fire and aerial bombs. The problem would have been insoluble ten years ago. But to-day it has not only been solved but solved by a large margin, for the actual weights of the two ships are, Nelson 33,500 tons and Rodney 33,900 tons. Such an achievement was only possible by the employment of special steels and alloys which the metallurgist has put at the command of engineers, by the exercise of the greatest care in design, and by the sacrifice of some of the amenities to which the Royal Navy is accustomed. Having gone this far we may hazard the suggestion that the limit has not yet been reached. It is said that the Germans have produced a 10,000-ton cruiser of quite phenomenal lightness, and it is, at least, conceivable that they have done so by a careful application of principles which have become the regular stock-in-trade of aeronautical engineering.

Each new industry as it comes into existence brings new knowledge into being. It is rarely indeed that that knowledge is not applicable in older industries. But if they are bound by their tradition they will fail to take advantage of it. It is just here that breadth of vision and an open mind are required. Such lectures as that delivered by Wing-Commander Cave-Brown-Cave to the engineers of the future are of much value. The young men whom he addressed have had no time to petrify. They are ready to receive new ideas, and we may confidently look to them to carry into the future and into other fields the lessons which may be derived from the most recent branch of mechanical engineering. There is no branch of engineering, certainly no branch of mechanical engineering, in which saving of weight is undesirable. Even the locomotive, which depends upon its weight for its adhesion, has problems of that kind. The reduction of the mass of moving parts need only be mentioned. In that direction something, perhaps, may be learnt from aeronautical engineering. Saving of weight, as the lecturer on Monday indicated, is partly connected with general design, and partly with detailed design, and the use of appropriate materials. In general design, as he showed in connection with the manner of grouping the cylinders of multi-cylinder engines, considerable weight can be economised, whilst in detailed design one must look to the saving of ounces and pounds here and there. It is in the use of stronger materials that savings may be effected without great departure from orthodox forms. Wing-Commander Cave-Brown-Cave offered to help any of the young men of the Institution, in any branch of mechanical engineering, in problems of weight-saving. Here is a field for a new expert, and who better than the man who has been trained by the conditions of aeronautical engineering to think in ounces. We suggest as an interesting experiment that the railway companies should invite some man so qualified to indicate to them how the weight of rolling stock could be reduced. That would make a good beginning for a new branch of mechanical engineering technique.

Literature.

Carbonisation, Technology and Engineering. By John Armstrong. London: Charles Griffin and Co., Ltd. 1929. Price 36s.

It may be doubted whether there is any real demand for a work purporting to cover the whole field of carbonisation of both coal and wood, and as regards the former by both high and low-temperature methods, because it is very exceptional for any one man to have to deal with all these processes. Even one of them, namely, the high temperature carbonisation of coal, includes two branches of technology, coke-making and gas manufacture, which are so distinct from each other that not a few separate treatises have been written dealing with each of them. Indeed, each one of these two branches of technology is so complex and so important that it requires an entire treatise to itself in order to deal with it adequately.

This fact alone would of itself cause anyone with experience of the subjects dealt with to expect that any treatise purporting to cover the whole ground would be more or less imperfect. Examination of the volume before us tends to confirm that impression. The author states in his preface that the subject "has progressed so rapidly that the older literature on the subject is somewhat out of date," but his own work is by no means free from that fault, being distinctly some years behind the most modern practice. Unfortunately, moreover, the author has not confined himself to his subject but has added chapters on such more or less related matters as the Constitution of Coal, the Preparation of Coal, and the Economic Combustion of Coal. The defects that are apparent in the rest of the work are particularly pronounced in these chapters. There is no need to treat seriously the crude theory which is put forward as to the formation of coal. It will not be considered deserving of a moment's consideration by geologists who have any acquaintance with the subject. The chapter on the Preparation of Coal is far behind the times. Thus, the important subject of Dry-cleaning of Coal is dismissed with the following curt sentence:—"Dry processes for separating the 'dirt' from the coal have been from time to time proposed and tried with little or no success, as far as can be ascertained in America." Seeing that processes of dry-cleaning are being adopted on all sides in this country and have already proved their value, that statement can only be taken as evidence that the author is not fully acquainted with the modern developments of this important subsidiary branch of the subject. The principle of the flotation process, which has been adopted in various collieries, both in this country and on the Continent for cleaning small coal is, again, quite misunderstood by the author, who gives the following definition:—"The 'Flotation process' consists briefly in the application of certain reagents such as acids or alkalis, which attack the metalliferous ore and discharge gas on the surface of the particles, forming small globules; the gas being lighter than water, buoys up the particles and causes them to float, whilst the silica and other non-metalliferous gangue, not acted on by the reagents, sinks to the bottom." This explanation might have been accepted as, at any rate, partially correct for one of the earliest flotation processes for treating a particular lead-zinc ore, but it is hopelessly incorrect as regards modern flotation processes, and in particular the flotation process as applied to coal. A little further down on the same page we meet with the following statement:—"There are some collieries which still follow the method of washing first, then classifying, as in the Baum washers." No one reading that sentence would imagine for a moment that the old Baum principle of washing before sizing had been adopted by practically all other makers of this type of washing machinery.

If a further example of the inadequacy of this section is required, it would be found in the description of what the author calls a "Vanner Table." With so many excellent treaties written by men who know what they are talking about, it seems a great pity that he should have gone out of his way to introduce a short chapter on the subject into which he has succeeded in introducing so many mistakes. The final chapter on the Economic Combustion of Fuel may be dismissed with the remark that throughout it the author has nothing to say on the subject of dust firing; and this from a man who speaks of other treatises as being somewhat out of date!

It looks as though the main object of this book were to call attention to a vertical coke oven designed by the author and erected at the works of the Coltness Iron Company, Ltd., for coking Lanarkshire coal. Not unnaturally the author extols the advantages of his form of coke oven in the manner common to the vast majority of inventors; he does not, however, mention the fact that although this invention appears to be now some twenty years old, all builders of modern coke-oven plants still build horizontal coke ovens. He gives quite a good historical account of the development of the Beehive coke oven, though somewhat unaccountably he omits all mention of the rectangular Welsh oven. He also describes well a number of the better known types of by-product coke ovens, stopping short, however, of the most recent practice; he evidently is not acquainted with the modern types of by-product ovens erected since 1926 in the Ruhr District, and even makes no reference to some of the most recent coke-oven plants erected in this country.

Perhaps the most surprising shortcoming in a book dealing with both coke oven practice and gas manufacture is the absence of any reference to a subject which has within the last few years attracted more attention than probably any other on the part of men engaged in both of these branches of technology, namely, the utilisation of coke oven gas for town gas purposes.

It is obvious that no one writing a really up-to-date book on the subject of the Carbonisation of Coal should fail to discuss in some detail this knotty and intricate problem, yet our author, who professes to be up to-date, does not consider it worth mentioning. It may be added that there is a short chapter on Low Temperature Carbonisation, which the author dismisses in twenty-five pages, about one-third of which is taken up with extracts of reports of the Government Research Department on the subject.

There are numerous illustrations, some of which are good and others quite the reverse.

Conduction of Electricity through Gases. Vol. I.: General Properties of Ions, Ionisation by Heat and Light. By Sir J. J. THOMSON, O.M., F.R.S., and G. P. THOMSON, M.A. Cambridge University Press. 1928. Price 25s.

THE first edition of this book was published in 1903, and although the preparation of this latest edition was begun some fifteen years ago, various circumstances prevented the distinguished authors from completing it until recently. The enormous growth of the subject has made it necessary to increase the work in this, the third, edition to two volumes, and in the first of these, which includes the subject-matter of the first ten chapters in the second edition, the general properties of ions are described and discussed. The majority of the original paragraphs have been retained, but the values of the fundamental constants have been replaced by the more accurate values obtained since the publication of the earlier editions. As the authors state, the material in some of the paragraphs deals with matters which are now chiefly of historic interest, but they claim, with reason, that there are advantages in maintaining continuity with the older editions, and, in addition, a book which is neither too mathematical nor too technical is likely to appeal widely, both to scientific workers and to those interested in science.

The rapid and remarkable development of the electrical phenomena occurring in gases may be estimated when it is remembered that even when the second edition of the book was written, J. J. Thomson's famous experiments on positive rays, which led to the discovery by Aston of Isotopes, had not been made. The Quantum theory was in its infancy; little, if anything, was known concerning the constitution of the atom; and the possibility of atomic disintegration by artificial means would have astonished most physicists. Spectroscopy almost stood aloof from electrical theory, crystal study by means of X-rays was unknown, and even the nature of the rays was not settled. To-day this volume of very respectable dimensions testifies to the wealth of researches that have followed the inception of Professor Thomson's theory that we know far more about the ion than about the uncharged molecule. The researches of the authors, and Rutherford, Townsend, C. T. R. Wilson, Zeleny, Rayleigh, H. A. Wilson, Langevin, Bohr and many others, are brought together in this book and correlated with the older researches and with those that have been proceeding simultaneously elsewhere.

In the two opening chapters the fundamental position is developed that the charge carried by the gaseous ion is the same for the ions of all gases, is independent of the ionising agency, and is equal to that carried by the hydrogen ion in electrolysis. This conclusion is arrived at from considerations of the diffusion velocity of the ions and their velocity in an electric field, and needs only the assumption that the ions behave like particles of a perfect gas towards pressure.

The earliest systematic measurements of the mobilities of the ions were made by Rutherford in the Cavendish Laboratory. Various experimenters have devised different methods, and eleven types of experiments are now described, by means of which this physical quantity may be determined. There seems to be a considerable divergence between the values obtained by different observers, suggesting that the mobilty may be affected to the extent of several per cent. by circumstances such as the purity of the gas, the age of the ion, the method of ionisation and other conditions which would naturally be different in different experiments, and which, if their influence were not suspected, might not have been specified. The chief interest in the values of the mobilities is the light they throw on the nature of the ions, and the authors are forced to the conclusion that the ions, if monomolecular, cannot remain unaltered during their path through the gas, but go through various phases in which they have different mobilities, and that the mobility, measured by the usual methods, is an average and not its value in any particular phase. The influence of different phases is shown most clearly by the carriers of negative electricity for which one of the phases is an electron, having a mobility many hundred times that of the other phase, the negative ion, so that even though the life of an electron is but a small fraction of the life of an ion, the existence of the electronic phase may make the average mobility considerably greater than that of the negative ion.

The various methods employed to measure the ratio of the charge of an ion to its mass are fully described, and it is shown that the whole mass of an electron is electrical in origin. This conception follows from the dependence of its mass on its velocity. In the case of positive ions the well-known experiments of Sir J. J. Thomson and Aston might have received fuller treatment, but the essential parts required by the student are given. Recently, Aston has made a very careful investigation of the slight divergencies from the whole number rule which, owing to the packing effect, occur for the elements other than hydrogen, and which had been suspected but not proved with the older apparatus. Dempster's work on the metals is mentioned, but there appears to be no simple rule to determine the number or weight of the isotopes of an element, and although many theories of nuclear structure have been brought forward they have not so far had much success in predicting isotopes. Elements of odd atomic number never have more than two isotopes, and when they have two the weights of these usually differ by two units. There is a general tendency for the number of isotopes of elements of even atomic number to increase with the atomic number, although there are plenty of exceptions.

Many experimenters have measured the charge carried by the negative ion, but probably the most important work is that carried out by Millikan, as it forms the most accurate series of researches so far made on the value of e. He claims that the evidence obtained in his work for the atomic nature of electronic charges is as strong as any of the chemical evidence for the law of multiple proportion and the atomic theory of matter. On this is based the authors' corpuscular theory of electricity. The electrons are the discrete particles of negative electricity, the presence or absence of which determines negative and positive electrification, and since the value of e/m for the positive ion is never greater than that for the hydrogen ion, it is concluded that a positive corpuscle or electron does not exist, and the positive ion consists of the whole atom less one electron. As the authors point out, the charge on an ion does not depend upon the kind of radiation used to liberate the ion; thus within the limits of experimental error, the charge on the negative ion, produced by the action of ultra-violet light, is the same as that on the ion formed by means of X-rays.

The condensation experiments of C. T. R. Wilson, together with the theory of the effect of the ions on condensation receive full treatment, and the theory in the chapter on ionisation by incandescent solids that electrons exist in free motion within metals and carbon, from which they escape when their kinetic energy is increased by rise of temperature is, as the authors state, of great importance in its bearing on the variation of chemical affinity with temperature. Indeed, this book will be read by chemists with interest for the light it throws upon the possible causes underlying phenomena often considered simple merely on account of their familiarity. The fact that metals and carbon emit electrons under these conditions may have an important application to some cosmical phenomena since, according to the generally received opinion, the photosphere of the sun contains large quantities of glowing carbon. This carbon will emit electrons, unless the sun by the loss of its electrons at an earlier stage has acquired such a large charge of positive electricity that the attraction of this is sufficient to prevent the negatively electrified particles from getting right away from the sun; yet even in this case, if the temperature were from any cause to rise above its average value, electrons would stream away from the sun into the surrounding space. We may therefore regard the sun, and probably any luminous star, as a source of negatively electrified particles which stream through the solar and stellar systems. When electrons moving at a high speed pass through a gas they make it luminous. Thus when the electrons from the sun meet the upper regions of the earth's atmosphere, they will produce luminous effects. It has been shown that many of the periodic variations in the Aurora Borealis may be explained if it is assumed that it is caused by electrons from the sun passing through the upper regions of the earth's atmosphere.

The passage of electricity through flames has been investigated by many men, but it seems to need further experimental study. There is a very intense electric field close to the negative electrode inserted in a flame, and a weak uniform field between the electrodes. The field near the positive electrode, although not nearly so intense as that close to the negative, is stronger than that at some distance from either electrode. When the vapours of salts are introduced into a flame the conductivity between the metallic terminals is greatly increased, and the electrical properties are simpler and more regular than in pure flames. It has been shown that if some potassium carbonate is put on one of two electrodes in flame, the difference in resistance in the two directions will rectify alternating current passed through the flame.

The concluding chapter deals with the ionisation by light, and includes the photo-electric effects. The various experiments described suggest that the photo-electrons, emitted when light is incident on metals, were originally free in the metal. If this is the case, the work required to remove a free electron from the metal should therefore be the same as the corresponding quantity determined from thermionic measurements. There is fair agreement between the values in the two cases. The rate of emission of electrons from some metals is much greater when a clean surface is first exposed to ultra-violet light than it is after the exposure has lasted for some time. The cause of this effect, known as "photo-electric fatigue," has not yet been fully explained, and the success of photo-electric cells as measures of light intensity shows that fatigue is not an essential part of the photo-electric phenomena.

This book will be welcomed by all those who are striving to keep up with the rapidly growing literature of an increasingly important subject. Although there are numerous references there is no bibliography. This omission seems a pity in these days of advanced specialisation. The book maintains in an enhanced degree its good qualities as a work of reference none engaged in the subject can be without; and as an authoritative exposition of a field of work the authors have made their own, it has its place among a wide circle of readers. The second volume will be awaited with interest.

SHORT NOTICES.

The A B C of Storage Battery Management. By Ernest C. McKinnon. The Chloride Electrical Storage Company, Clifton Junction, Manchester. Price 3s. 6d.—Although much has been written on the management of storage batteries, this second edition of Mr. McKinnon's book is probably the most useful work on the subject. It is essentially practical, and it is written on simple and straightforward lines. It contains exactly the information which users of storage batteries require. In the absence of proper instructions, storage batteries may lead to no end of trouble and expense, notwithstanding all the modern improvements. The knowledge of what to guard against is of vital importance to all who use storage batteries, and we know of no book that gives the necessary information in a more simple form.

Success on Irrigation Projects. By John A. Widtsoe, Ph.D., LL.D. London: Chapman and Hall, Ltd. 1928. Price 8s. 6d.—Though he deals usefully with engineering and farming, in irrigation, the author of this compilation of lecture notes for a course in irrigation economics in an American Agricultural College, is mainly concerned to present the social and economic aspects of irrigation. Thus those aspects are discussed, not unduly, in connection with the location of new projects and other technical matters, while they dominate the chapters on "The People and the Project" and "Helping the Farmer," in which the temperament of the water user, the evils of debt and other vital matters are discussed. Good, practical guidance is given in regard to finance and the use of irrigation water. Written for statesmen and farmers, this useful book may especially be commended to the notice of those classes in South Africa, Greece, Turkey, and other countries.

Underground Cable Systems. By G. W. Stubbings. London: Chapman and Hall, Ltd. Price 15s.—The author endeavours to give in this book an account of the theory and practice of the distribution of electricity by underground cables, and the volume is expected to appeal to engineers engaged on the distribution side of electricity supply undertakings. For the most part the book is written on thoroughly practical lines, and it contains much of interest to those who are in need of information concerning the laying, jointing, and testing of cables. The most theoretical chapter is Chapter II., which deals with the physical constants of cables. Other branches of the subject dealt with besides those mentioned are cable networks, the insulation resistance of a cable network, faults on cable networks, cables for extra high pressures, automatic protective systems, electrolytic corrosion of cable sheaths, mains, plans, and records and tests and measurements. The chapter on high-pressure cables does not purport to be more than an elementary sketch of the subject.

BOOKS RECEIVED.

Locomotive Engineer's Pocket Book, 1929. London: The Locomotive Publishing Company, Ltd., 3, Amen-corner, E.C. 4. Price 3s. 6d.

Journal of the Institute of Metals. Volume XL. Edited by G. Shaw Scott, M.Sc. London: The Institute of Metals, 36, Victoria-street, S.W. 1.

The Theory of Heat Engines. Third edition. By Wm. Inchley, B.Sc. Longmans, Green and Co. Ltd., 39, Paternoster-row, E.C. 4. Price 12s. 6d. net.

Chemical Engineering and Chemical Catalogue. Fifth edition. Edited by D. M. Newitt, Ph.D., &c. London: Leonard Hill, Ltd., 231, Strand, W.C. 2. Price 15s. net.

Annales des Ponts et Chaussées: (1) *Partie Technique, and* (2) *Partie Administrative.* 1928. Tome II., Fasc. VI. Novembro-Décembre. Paris: 6, Rue de la Chaussée-d'Antin.

Blast-furnace Practice. Vol. I. General Principles: Source, Preparation and Handling of Raw Materials. By F. Clements, M. Inst. C.E., M.I. Mech. E. London: Ernest Benn, Ltd., 154, Fleet-street, E.C. 4. Price £3 3s. net.

The Companies Act, 1928, as it Affects the Business Man. Being a reprint of an address delivered to the members of the Rotherham Chamber of Commerce on March 8th, 1929, by Sir Mark Webster Jenkinson, K.B.E., F.C.A. London: Gee and Co. (Publishers), Ltd., 6, Kirby-street, E.C. 1929.

Proceedings of the Thirty-first Annual Meeting of the American Society for Testing Materials. Vol. 28. Part I., Committee Reports. New and Revised Tentative Standards. Part II., Technical Papers. Philadelphia, Pa.: The American Society for Testing Materials, 1315, Spruce-street. Price 6 dollars per part; 8 dollars per part in half-leather binding.

The Proposed Remedial Works at Niagara Falls.

AN agreement has recently been concluded between the Governments of Canada and the United States, whereby certain remedial works will be undertaken on the Niagara River, which, it is hoped, will result in the preservation of the scenic beauty of the famous Horseshoe Falls. This agreement represents the culmination to date of the investigatory work which the Governments of the two countries have had under way in the Niagara River for the past two years for the purpose of: (*a*) determining how the beauty of the falls and rapids could best be maintained; (*b*) ascertaining by what means and to what extent the impairment thereof by erosion or otherwise could be overcome; and (*c*) of determining what quantity of water might, without detriment, be permitted to be diverted from the river for power purposes. Effect is being given by the agreement to the recommendations of the Special International Niagara Board, appointed in 1926 by the two Governments to investigate and report on the matter.

We discussed, in our issue for April 6th, 1928, the initial findings of this Commission, as outlined in an interim report, which had been issued just before that date. It will be observed from what follows that the recommendations of the Commissioners have been adopted in their entirety, the works, which it has now been decided to carry out, being, with slight modifications, identical with those set out in the report. To make this article complete in itself, we give a general outline of the proposals, but for those desiring more detailed particulars, we would suggest a study of the former article.

FIG. 1—THE CANADIAN AND AMERICAN FLANKS OF THE HORSESHOE FALLS SHOWING EXTENT OF DEWATERING

It has been decided that remedial works, designed so to distribute the water of the river as to ensure at all seasons unbroken crest lines on both the Canadian and American Falls, shall be constructed in the river above the Falls. The outstanding effect of this provision will, it is confidently anticipated, be the reclothing, with a substantial flow of water, of the two flanks of the Horseshoe Falls which have been so long denuded. Exposed shoals will be removed and a better distribution of water secured throughout the rapids and over both falls. After studying the entire situation, the Special International Board reached the conclusion that the type of construction best suited properly to rewater the flanks of the Horseshoe Falls is a combination of excavations and submerged weirs carried from the shores near the flanks into the adjacent main currents only far enough to accomplish the desired deflection of water to the flanks. This plan is susceptible of progressive extension upstream and into the rapids to the extent required to mask the effect of any reasonable additional diversions which may be agreed upon. In conjunction with these flanking weirs a further submerged weir is proposed at the lower end of the Grass Island Pool. The cost of the entire undertaking has been estimated at 1,750,000 dollars—say, £350,000.

The general appearance of the Falls has been the subject of serious consideration by the two Governments since 1905. Surveys made between 1764 and 1927 indicate a continuous recession of the central portion of the crest line of the Canadian Falls. The effect of this recession has been to lengthen the crest and to leave the flanks of the Horseshoe on either shore more or less denuded of water, the degree depending upon the total volume of the flow over the Falls. The low cycle of levels in the Great Lakes System for several years past, culminating in the extreme low water of 1925–26, has been reflected in the flows of Niagara River, which reached the minimum on record in February, 1926. These low flows have augmented the baring of the flanks of the Horseshoe Falls, and reduced the supply available for the American Falls. The withdrawal of water from the Great Lakes and the Niagara River for navigation, sanitary and power purposes, has had the effect of reducing the total flow available for the falls and rapids immediately above, by gradually increasing amounts from a yearly average of 900 cubic feet per second in

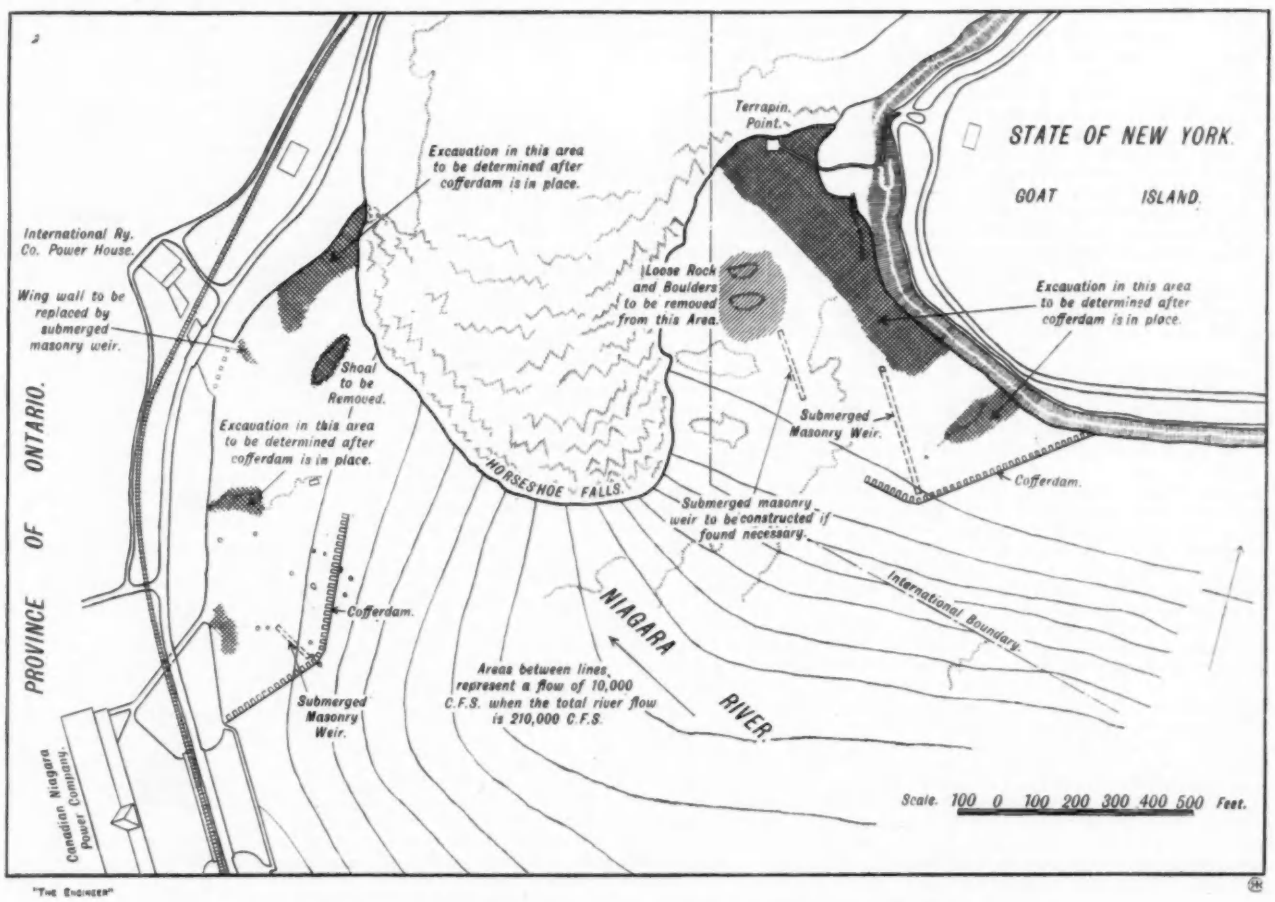

PROVINCE OF ONTARIO.
STATE OF NEW YORK.
GOAT ISLAND.
Terrapin Point.
Excavation in this area to be determined after cofferdam is in place.
International Ry. Co. Power House.
Wing wall to be replaced by submerged masonry weir.
Loose Rock and Boulders to be removed from this Area.
Excavation in this area to be determined after cofferdam is in place.
Shoal to be Removed.
Excavation in this area to be determined after cofferdam is in place.
Submerged Masonry Weir.
Cofferdam.
HORSESHOE FALLS.
Submerged masonry weir to be constructed if found necessary.
International Boundary.
Cofferdam.
NIAGARA RIVER.
Areas between lines represent a flow of 10,000 C.F.S. when the total river flow is 210,000 C.F.S.
Submerged Masonry Weir.
Canadian Niagara Power Company.
Scale. 100 0 100 200 300 400 500 Feet.
"THE ENGINEER"

FIG. 2—PLAN SHOWING PROPOSED REMEDIAL WORKS ABOVE THE HORSESHOE FALLS

the year 1860 to some 64,000 cubic feet per second in 1927. Of this total, about 12,000 cubic feet per second are diverted from the Great Lakes System through the works of the Chicago Sanitary District, the Welland Canal, and the New York State Barge Canal. The power water at Niagara is limited by the treaty to "not exceeding in the aggregate a daily diversion at the rate of 56,000 cubic feet of water per second." At present, this authorised power diversion is utilised to the fullest extent practicable with

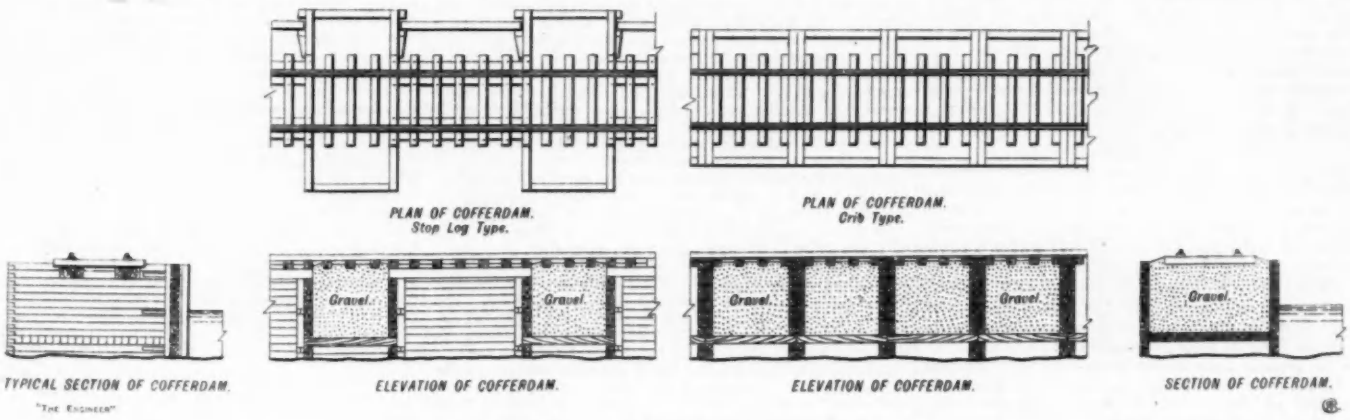


FIG. 3—ARRANGEMENT OF COFFERDAMS

present installations, resulting in diversions as follows:—

	c.f.s.
Average annual diversion	52,075
Average Sunday diversion	42,766
Average weekday diversion	53,625
Average weekday diversion during daylight hours, about	61,000

This withdrawal of water has reduced the flow in both the American and Canadian channels, and has increased the unwatering of the flanks of the Horseshoe. The extent of this dewatering is well shown in Fig. 1, which has been reproduced from photographs showing the Canadian and United States flanks. The water used to flow over these rocks that are now seen bare. At the same time, however, this reduction in the total flow has in some measure retarded the rate of erosion.

There are two deep and swift channels in the rapids just above the Horseshoe Falls, which are separated by an area of quite shallow water. It is evident that the two strong currents have, since about the year 1800 and possibly for many years before, converged and met near the central part of the river, thus causing especially rapid erosion in the central part of the fall. Erosion at the flanks, particularly at the Goat Island shelf at the United States end of the fall, has practically ceased, owing to the draining of water from the shelf by the upstream movement of the Horseshoe and the diversion of water for power purposes. The further condition exists that when the main fall was passing the Goat Island shelf, the water at the shelf was not sufficient to cut through the hard stratum of rock which lies near the surface of the "Maid-of-the-Mist" pool below the falls, thus allowing a talus of large rocks, which fell from the cliff, to rest upon the stratum at the base, and effectually prevent undercutting at that part of the fall. The rate at which the central part of the Horseshoe moves upstream has been several times calculated in recent years, the determined rate in each case depending somewhat upon the definition given to the movement and the method used in the calculation. The latest determination made by the Special International Niagara Board, with the aid of competent geologists, and considering only the actively cutting central part of the fall, shows a mean rate of recession of the crest of 3·7ft. per year since 1842, and of 2·3ft. per year since 1906. The direction of maximum recession is now, and has been for more than twenty years, up the deep channel on the Canadian side, and not in the so-called "notch," where, of recent years, the recession has been almost negligible. The Horseshoe is now cutting back at a decreasing rate, and, according to the observations of the Special International Board, the rate will continue to decrease.

The recession of the American Falls is negligible. In the time since those falls became separated from the Horseshoe, the crest line has not receded much, if any, more than the dry crest of the adjacent walls of the gorge. This condition is due to the fact that the flow over the flank of the main fall, as it receded along and past the face of the present American Falls, was not sufficient to cut through the hard stratum at the foot, thus leaving a resting place for the huge masses of rock which fell from the cliff, and which now form the talus at the foot of the falls. There has never been a sufficient flow over the American Falls to cause any material wearing away of this talus, which, so long as it exists, prevents undercutting and consequent erosion.

Article 2 in the agreement provides that, concurrently with the construction and tests of the remedial works, and as a temporary and experimental measure, diversions of water of the Niagara River, additional to the amount specified in the Boundary Waters Treaty of 1909, will be permitted to the extent of 10,000 cubic feet of water per second on each side of the river. These additional diversions are to be allowed during the winter, or non-tourist season, beginning on the first day of October and ending on the thirty-first day of March of the following year. This provision for diversion will terminate seven years from the date of the initial additional diversion authorised.

The Hydro-Electric Power Commission of Ontario and the Niagara Falls Power Company of Niagara Falls, New York, have agreed to construct the remedial works at their own cost, conditioned upon their being permitted to utilise in their existing power stations the 10,000 cubic feet per second additional water which it is intended should be withdrawn from each side of the river.

With regard to the water diversion end of the undertaking, the Special International Board reported as follows:—

"(1) A further and most important end which this initial construction serves, is the opportunity afforded the two Governments to actually test out in practice the effect of temporary additional withdrawals of water and the efficiency of remedial works to offset such withdrawals.

"(2) Adequate facilities for additional water passage can be provided in the existing power stations on both sides of the river to permit of substantial additional withdrawals of water at such times and for such periods as will most effectively demonstrate the sufficiency of the remedial works to offset the same. No more effective demonstration is possible than that provided by direct observation on the falls themselves."

The various types of remedial works which were considered by the Special International Board were tested on a model of the Falls built by the Niagara Falls Power Company.* While the model demonstrations served a most useful purpose in indicating the general results which might be anticipated from different types of remedial works, it was not felt that the specific performance of works of this character and magnitude in the turbulent water of the upper rapids could be successfully predicted as the result of the experiments on even the most accurately constructed small-scale models. The model demonstrations have, however, effectively shown that remedial measures which will greatly improve the scenic value of the Falls are eminently practicable.

In their acceptance of the proposal to construct the remedial works, the Hydro-Electric Power Commission of Ontario and the Niagara Falls Power Company say: "The facilities for additional temporary withdrawals of water through existing power stations of the Commission and the company are sufficient to utilise a daily diversion from above the Falls of Niagara at the rate of 20,000 cubic feet per second, in addition to the daily diversion at the rate of 56,000 cubic feet per second now permitted and diverted under the Boundary Waters Treaty of 1909. The additional water so diverted may be put to beneficial use in the generation of power to be supplied to customers in the territories within the province of Ontario and the State of New York, now served by Niagara power. Under these circumstances, the Commission and the company jointly have prepared drawings—[which are reproduced herewith]—showing works in the Niagara River which it is believed conform to the recommendations of the Special International Niagara Board. These drawings are marked A, B and C."

According to the plans which have been approved by the Governments of Canada and the United States, a coffer dam will be built on the American side, commencing at a point on Goat Island, about 1100ft. upstream from Terrapin Point, and will be extended out into the river in a direction at an angle of about 45 deg. to the shore line, for a distance of about 400ft.

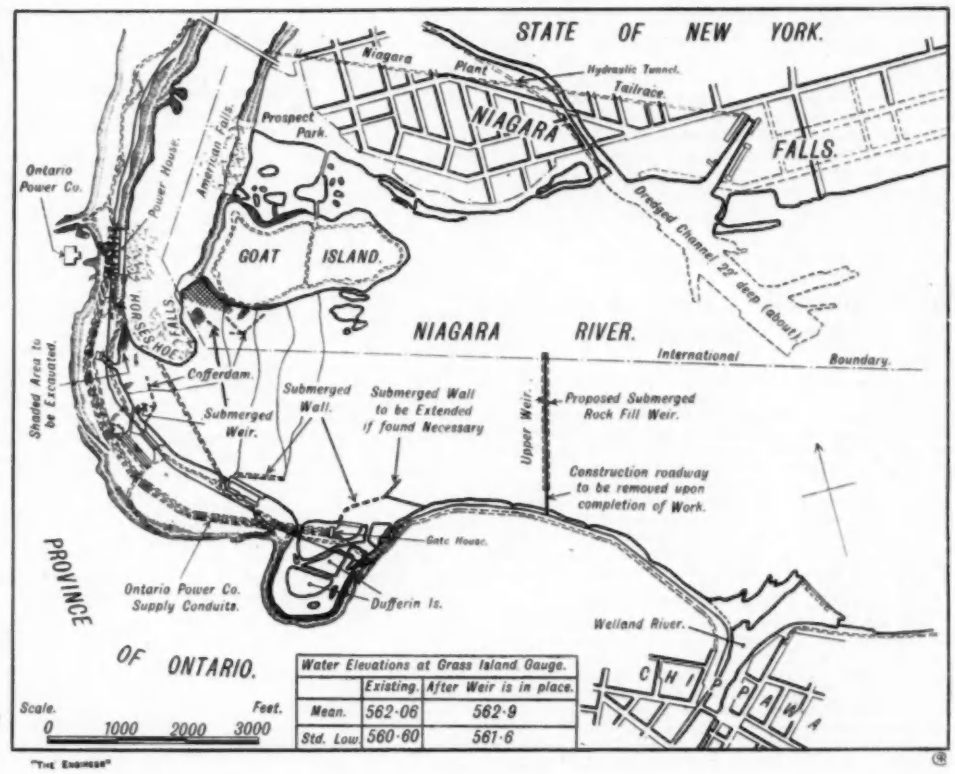


FIG. 4—GENERAL PLAN OF NIAGARA RIVER ABOVE THE FALLS

* This model was illustrated and described in the issue of THE ENGINEER for October 28th, 1927.

At that point the cofferdam will be extended downstream for a distance of about 150ft. This cofferdam will unwater the bed of the river below it and a section of the crest of the Horseshoe Falls for a distance of about 600ft. or 700ft. from Terrapin Point. Within the area thus unwatered, the bed of the river will be excavated to the extent and depths to be determined by the Permanent Niagara Control Board, and one or more submerged masonry weirs will be built approximately in the positions shown in the drawing, Fig. 2. The areas cross-hatched indicate approximately the extent of the excavation and the dotted lines the length and position of the weirs. The depth of the excavation will not exceed 3ft. or 4ft.

The cofferdam will be constructed of timber cribs, or of timber cribs and stop logs, as shown in the drawing, Fig. 3, in such a manner that the stop logs or portions of the cribwork may be removed and the water allowed to flow over the unwatered area, so that the effect of the works may be observed before the cofferdams shall be removed. It is intended that the submerged masonry weirs will deflect some of the water from its natural channel and the excavated areas will cause a sufficient quantity of water to flow close to the shore of Goat Island and over the crest of the Falls in the vicinity of Terrapin Point. If the observed effect is not all that may be desired, the stop logs or cribwork can be replaced and such additional work done as may be necessary.

A cofferdam is also to be built on the Canadian side. It will start at a point just below the intake to the forebay of the Canadian Niagara Power Company's plant, and will be extended out into the river in a direction about 45 deg. to the shore line for a distance of about 300ft. At that point it will be turned downstream for a distance of about 400ft. This cofferdam will unwater the bed of the river below it, and a section of the crest of the Horseshoe Falls for a distance of about 400ft. from its extremity at the Canadian shore. Within this area excavations will be made and submerged wiers built, as directed by the Permanent Niagara Board, in the same manner as that described above to be done on the American side. The cross-hatched areas and dotted lines indicate approximately the areas to be excavated and the length and position of the weirs to be built. It is intended that the effect of these works shall be to cover the Canadian end of the Horseshoe with a sufficient quantity of water.

Fig. 4 is a general map showing the positions of the works above described, and also the position of a submerged weir which it is proposed to build in the Chippawa-Grass Island Pool for the purpose of raising the level of the pool, so as to increase the flow of water down the American channel and over the American Falls. This weir is to be built about 1700ft. upstream from the intake to the plant of the Ontario Power Company, and will extend out into the river for a distance of about 2200ft. It is designed to be constructed of loose rock fill. Two methods for its construction are indicated; the one to be used where the bed of the river is hardpan, and the other where the bed is solid rock. It is anticipated that the weir will raise the standard low-water level of the Chippawa-Grass Island Pool approximately 1ft., which will be sufficient to increase the flow over the American Falls by about 2500 to 3000 cubic feet per second.

The Propulsion of Ships by Modern Steam Machinery.*

By J. JOHNSON.

Historical and other analogies have been invoked to show that steam propulsion has run its course and must now give way to more efficient machinery. Analogies, however, are sometimes constructed out of insufficient or unsuitable material and in such cases may be dangerously misleading. It is the author's purpose to examine the more efficient forms of steam propulsion, and, incidentally, to compare them with the Diesel engine.

Reliability is a major factor in all ships, increasing in importance with size and speed, until in the largest vessels it governs all other considerations. Whether the vessel be large or small, freedom from dislocation of service is being insisted upon in increasing degree by owners, who are well aware that fuel or other economies have to be seriously discounted if associated with interruptions in trading operations. Nevertheless, the demand for reduction in first cost of the vessel and for substantial economies in fuel is very insistent, and, in so far as these are attainable by technical advances in the propelling agent, they must receive serious consideration.

Apart from small installations for which the triple or quadruple-expansion reciprocating engine is specially suited, there are three types of steam plant, each with its variants, prominently in use and applicable over a wide range of tonnage.

(*a*) The combination of reciprocating engine and low-pressure turbine.

(*b*) The single-reduction geared turbine, using low-pressure superheated steam generated in Scotch boilers.

(*c*) The single-reduction geared turbine, using high-pressure superheated steam generated in water-tube boilers.

In order to illustrate these alternatives comparison has been made of the performances of a number of passenger and cargo vessels engaged in the North Atlantic trade, representative of the low-pressure, moderate temperature, steam system at an advanced stage of its evolution, and the high-pressure, high temperature steam system at the initial stage of its development.

A study of the claims of steam plant present or prospective, must necessarily be preceded by full consideration of the condenser problem. In this connection the histories of the "Melita's" and "Minnedosa's" main condensers are of especial interest as examples of acute tube deterioration. They are of the "Uniflux" type, with relatively high-velocity cooling water. The Admiralty mixture brass tube—70 Cu, 29 Zn, 1 Sn—had an average life of one year with or without an electrolytic process, but a few months of service produced failures sufficiently numerous to be an embarrassment under service conditions. In February, 1925, the "Minnedosa's" condensers were re-tubed with cupro-nickel tubes of 80 Cu, 20 Ni composition. At the same time, the "Melita's" condensers were tubed with alternate rows of 90 Cu, 10 Ni and 85 Cu, 15 Ni. There were no failures in either vessel during the ensuing year, and on examining a large batch from each condenser no sign of deterioration was found in the 80/20 tubes, and only the slighest suspicion of corrosion in the 85/15 tubes. The 90/10 tubes, however, exhibited the same appearance as the earlier brass tubes, practically the whole of the interior surfaces being lightly pitted. Although no perforation had occurred, it was clear that a comparatively short life only might be expected of these tubes. It was concluded, therefore, that anything less than 20 per cent. of nickel was not sufficient, that 20 per cent. might be adequate, but that an increase in the nickel content would probably be beneficial. The tubes in the "Melita's" condensers were replaced by 80/20, and a proportion of 70/30 (CuNi) tubes introduced, the latter being commercially available at this juncture.

During the second year there were no failures in the "Minnedosa's" condensers, and in January, 1927, after two years' service, a batch of tubes was withdrawn from both port and starboard condensers and subjected to careful scrutiny, when no indication of general deterioration was observed.

During the third year there were four failures, and at the annual overhaul in December, 1927, 100 tubes were withdrawn from each condenser. These were very carefully examined, and while their general condition was good, there were signs of slight corrosion in irregular patches, principally towards the ends, the depth varying from 0·004in. to 0·010in. (Original thickness, 18 W.G. = 0·048in.)

During the fourth year there were two failures, and at the overhaul in December, 1928, batches of tubes were drawn and subjected to a microscopic examination.

There have been only six tube failures in four years, and there is reason to believe that these had their origin in manufacturing defects. The most recent examination would seem to indicate that the life of these tubes will not be less than six years. There are fair grounds for supposing that the life of 70 Cu, 30 Ni tubes will be much longer in condensers designed on modern lines. In view of the severity of the case, the first two years' experience with the 80/20 tubes was thought to warrant the belief that a partial solution of the condenser problem was within reach. On the strength of this result, together with growing evidence in other quarters, it was decided that the question of adopting high-pressure water-tube boilers was ripe for examination. The performances of the "Melita" and "Minnedosa" are a convenient starting-point in the proposed review. These vessels are propelled by the well-known combination consisting of four-cylinder reciprocating engines driving the wing screws, exhausting into a low-pressure turbine actuating the centre screw. Steam is supplied by five double-ended boilers, hand fired, with Howden's forced draught. This type of machinery is installed in several important vessels, but, so far as the writer is aware, was until recently used only in association with saturated steam. In February, 1925, superheaters were installed in the "Minnedosa's" boilers, and appropriate modifications made to her propelling machinery. A year later new propellers were fitted. Log abstracts from typical summer Atlantic passages, before and after the alterations were made, are given in Table I.

The fuel rate per S.H.P. hour is derived from the combined indicated and shaft horse-powers, adjusted to a basis of shaft horse-power by assuming a mechanical efficiency of 92 per cent. for the wing engines. As the boiler efficiency is of the order of 74 per cent., it is evident that an installation of this kind, using oil fuel and Scotch boilers having an efficiency of 82 per cent., might be expected to show a rate of 0·70 lb. per S.H.P (propulsion); the coal coefficient 25,000, would thus become 38,500 for oil; a result rather better than is registered in the same service by somewhat similar twin-screw vessels built in 1922 and fitted with double-reduction turbines using steam superheated 150 deg. Fah.

Interest in the combination type of machinery has recently been revived by the advent of the Bauer-Wach, Parsons, and other systems, which are thermally similar, but have the advantage of avoiding the use of a low efficiency centre screw of high revolutions. In such installations of this power, about 11,000, the fuel coefficient, using oil, would probably be in the region of 40,000. An appreciable amount of oil is required for internal lubrication in reciprocating engines, and this cannot be removed with the degree of certainty essential for water-tube boilers. This precludes the use of such machinery in association with high-pressure steam.

A description of the "Empress of Australia's" machinery conversion has appeared in the technical Press,† but perhaps some further observations may opportunely be made here. The original water-tube boilers were extremely inefficient, of indifferent construction, and in a poor state of repair. Moreover, the vessel had about 1500 tons of permanent ballast. Having regard to all the circumstances, it was decided to adopt Scotch boilers of 220 lb. working pressure, fitted with smoke-tube superheaters capable of yielding a temperature of 620 deg. Fah. Considerable attention was given to the design of the new main and auxiliary machinery, boilers, and feed heating, but nothing of a novel character was introduced beyond two 165-kW Diesel generators, sufficient for ship's lighting and forced draught fans. Typical results registered on fair weather passages with the new installation are set out in Table II., from which it will be seen that the oil consumption is down to 0·65 lb. per S.H.P., raising the coefficient to 42,000. The boiler efficiency maintained in service is 83 per cent.; steam rate of the Parsons turbines 8·30 lb. per S.H.P.-hour—turbines only, and the feed temperature obtained by the use of auxiliary exhaust and low-pressure bled steam 230 deg. Fah.

Table II.—*Performance of ss. "Empress of Australia."*

Item.	West.	East.
Speed, knots	19·26	19·48
S.H.P.	19,500	20,346
Daily consumption (propulsion), tons	136	142
Pounds oil per S.H.P. per hour—		
Propulsion	0·65	0·65
All purposes	0·71	0·71
$D^{\frac{2}{3}} V^3 \div$ S.H.P.	290	294
$D^{\frac{2}{3}} V^3 \div$ tons day (propulsion)	41,500	42,100

Table I.—*Performance of ss. "Minnedosa."*

	Year.	Speed, knots.	Total S.H.P.	Tons of coal per day (propulsion).	Pounds of coal per S.H.P. hour. Propulsion.	Pounds of coal per S.H.P. hour. All purposes	$D^{\frac{2}{3}} V^3$ / S.H.P.	$D^{\frac{2}{3}} V^3$ Tons day (propulsion).
Saturated steam (original propellers)	1924	16·33	11,500	158	1·28	1·41	255	18,500
Superheated steam (150 deg. Fah.) (original propellers)	1925	16·53	11,650	137	1·09	1·22	253	21,500
Superheated steam (150 deg. Fah.) (new propellers)	1926	16·45	10,600	123	1·08	1·22	286	24,650
	1927	17·08	11,500	133	1·08	1·21	290	25,000

The "Duchess" Class Liners.

The "Duchess of Bedford," commissioned in 1928, was the first of four passenger vessels built to the order of the Canadian Pacific Railway Company for their Liverpool-Montreal service, in which high-pressure steam and water-tube boilers are employed. Before examining in detail the issues involved by the use of this high-pressure high-temperature steam it is desirable to compare her service results with those of the earlier vessels—see Table III. The boiler efficiency maintained in service is 85 per cent., steam rate 7·3 lb. (turbines only), and feed temperature 300 deg. Fah.

In order to complete the comparison the results of the "Empress of Canada" and "Montclare" have been included. These vessels, built in 1922, are propelled by double-reduction geared turbines, steam being supplied by Scotch boilers, pressure 215 lb. The former uses saturated steam and the latter steam superheated to 550 deg. Fah. The "Minnedosa" figures are converted for oil.

Putting technical comparisons on one side for a moment, it is of interest to note that the "Duchess of Bedford," 20,000 tons, has made a complete voyage Liverpool-Montreal-Liverpool on a total of 1443 tons of fuel, inclusive of port consumption, at an average speed of 17·8 knots, as compared with a voyage of the "Montclare," 16,314 tons, under similar weather conditions, at a speed of 16·35 knots and a consumption of 2182 tons, or 34 per cent. less fuel.

As the "Empress of Australia" may be considered representative of the low-pressure steam system at its best, it is instructive to compare the essential features of her installation, in terms of space, weight, and fuel consumption, with those of the "Duchess of Bedford." The figures show a reduction of 16 per cent. in space 12 per cent. in weight, and 12 per cent. in fuel rate in favour of the "Duchess of Bedford."

Table III.—*Comparative Performance of Different C.P.R. Steamers.*

Ship.	S.H.P. (on service).	Daily consumption of oil, tons (propulsion).	Fuel per S.H.P. hour. Propulsion.	Fuel per S.H.P. hour. All purposes.	$D^{\frac{2}{3}} V^3$ / S.H.P.	$D^{\frac{2}{3}} V^3$ Tons day (propulsion).	Thermal conditions. Pressure at engines.	Thermal conditions. Temperature at engines.	Thermal conditions. Vacuum.
								Deg.	Inches.
"Empress of Canada"	20,000	225	1·05	1·13	307	27,200	185	Saturat'd	28·5
"Montclare"	12,500	117	0·87	0·98	284	30,300	200	500	28·7
"Minnedosa"	11,500	86·5	0·70	0·785	290	38,500	207	530	29
"Empress of Australia"	20,346	142	0·65	0·71	294	42,100	190	580	29
"Duchess of Bedford"	16,000	97	0·57	0·625	293	48,000	340	670	29
"Duchess of Atholl"	16,100	99	0·58	0·64	284	46,000	340	680	29

* Institution of Naval Architects, March 21st, 1929.

† See The Engineer, January 17th, 1927.—Ed. The E.

The "Empress of Canada" is now being re-engined and having superheaters fitted to her boilers. The installation will be exactly similar in its essential features to that of the "Empress of Australia," but the service power will be 26,000. A new vessel, the "Empress of Japan," in course of construction will have a high-pressure installation of 30,000 S.H.P., working pressure 375 lb., and steam temperature 700 deg Fah. The consumption rates for all purposes for the "Empress of Canada" and "Empress of Japan" are expected to be 0·70 lb. and 0·60 lb. respectively, and there is every reason to believe that these figures will be comfortably realised. This represents a saving in the fuel rate for the high-pressure system of 14 per cent. The saving in space and weight will be about 15 per cent. and 12 per cent. respectively.

The following table shows the comparative weights of the installations :—

TABLE IV.—*Machinery Powers and Weights.*

Ship.	S.H.P. (des'd).	Total weight of propelling machinery and boilers (including water).	Weight of machinery, boilers, and water per S.H.P.
		Tons.	Tons.
"Empress of Canada" ..	20,000	3,400	0·17
"Montclare"	12,500	2,411	0·193
"Minnedosa"	11,350	2,097	0·184
"Empress of Australia"	20,000	2,850	0·143
"Duchess of Bedford"	18,000	2,275	0·126

The question of the relative costs of high-pressure, high-temperature water-tube boiler plant and low-pressure, moderate-temperature Scotch boiler plant calls for special remark. In order that a high efficiency may be attained with the conventional design of water-tube boiler, it is essential that the evaporative rating shall not exceed that adopted for Scotch boilers with superheaters, namely, about 5·0 lb. to 5·5 lb. per square foot of generative surface. Allowing for the difference in steam rate, the water-tube boiler generative surface may be 10 to 15 per cent. less.

The relative costs of water-tube and Scotch boilers are set out in Tables V. and VI.:—

TABLE V.—*Particulars of Scotch and Water-tube Boilers.*

Scotch boiler (complete ex shop): Cost, £8100; duty, 33,350 lb. of steam per hour (85 per cent. superheated, 15 per cent. saturated); evaporation per square foot heating surface, 5·33 lb.; working pressure, 220 lb.; heating surface (oil basis), 6250 square feet; smoke tube superheater, 620 deg. Fah.; all mountings, lagging, superheaters, air heaters, furnace fronts, smoke-boxes and uptakes to funnel base.

Water-tube boiler (complete ex shop): Cost, £6900; duty, 27,800 lb. of steam per hour (all superheated); evaporation per square foot of heating surface, 5·34 lb.; working pressure, 350 lb.; heating surface, 5200 square feet; integral superheater, 680 deg. Fah.; all mountings, lagging, superheaters, furnace fronts and uptakes and air heater to funnel base.

In high-powered passenger vessels, such as are exemplified in Table VI., which shows schemes for water-tube and Scotch boilers for powers from 13,000 up to 60,000 S.H.P. service powers, reserve boiler power is, of course, invariably provided. The comparisons in all cases have been made on the basis of an evaporative rating of about 5·4 lb. per square foot of generative surface, calculated on the overload power, which is in each case 10 per cent. in excess of the service power. This also provides for the contingency of a fraction of the boilers not being immediately available on leaving port after a shortened stay or the shutting down of boilers in emergency at sea. Under any but abnormal circumstances the evaporative rating at the service power would not exceed 6 lb. All comparisons made between water-tube and Scotch boilers are in this sense on a perfectly comparable basis.

For 18,000 S.H.P., using boilers of the type indicated in Table V., the high-pressure installation costs about the same as Scotch boilers. When the "Duchess of Bedford" installation was projected, selection of the number and size of the boilers were influenced to a considerable extent by the somewhat hypothetical nature of the case. In the light of actual experience the installation might quite prudently comprise four larger water-tube boilers and two smaller Scotch boilers. The high-pressure water-tube boiler does not, however, show to full advantage until larger units are employed, as illustrated in the following cases. Apart, however, from the actual boiler costs, a pronounced simplification of steam pipe systems and incidental fittings is secured, the full advantage of which only becomes apparent from a study of the completed detail designs of the "Empress of Japan" Fig. 1 and the "Empress of Canada" Fig. 2 shown below.

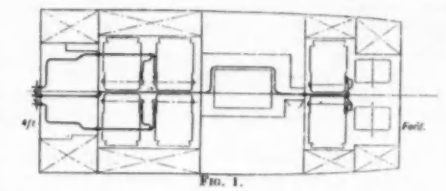


FIG. 1.

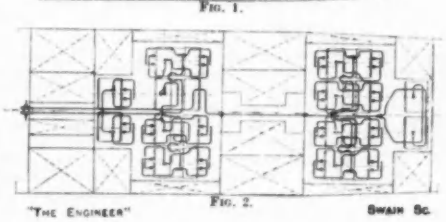


FIG. 2.

STEAM PIPE ARRANGEMENTS

With high-pressure machinery the condensing surface for a given S.H.P. may also be reckoned at 15 per cent. less, due to lower steam rate and greater proportion of bled steam. The whole of the propelling and boiler-room auxiliaries are also correspondingly smaller. Notwithstanding the extra cost of special material for high-pressure turbine blading, the gross cost does not exceed that of the larger low-pressure set. The position is summarised in Table VII.

TABLE VII.—*Costs of L.P. and H.P. Steam Plant.*

	Total cost of installation.		
	18,000 S.H.P.	30,000 S.H.P.	60,000 S.H.P.
	£	£	£
Low-pressure steam plant	266,000	408,000	735,000
High-pressure steam plant	256,000	390,000	690,000

In both types of plant electrically driven auxiliaries have been allowed for, turbo and Diesel generators being included.

Having regard to the fact that water-tube boilers are used exclusively in the British and other navies, and in all modern power stations throughout the world, at pressures ranging from 250 lb. to 1300 lb., it cannot be seriously maintained that there is to-day any insuperable obstacle to their more general adoption in mercantile vessels. It is, however, recognised by all engineers experienced in the best water-tube boiler practice that de-aerated pure feed is essential for success, more particularly with high pressures.

In the "Duchess of Bedford" and sister vessels the use of high-pressure, high-temperature steam is confined to the main units, turbo-generators and turbo-feed pumps, where thermally advantageous. In these units no internal lubricant is necessary, and there is, consequently, no dependence on filters. A small Scotch boiler is used to supply steam for the low-pressure service of the vessels. Connections are provided from this low-pressure saturated range to an intermediate stage of the main turbines, and also through a reducing valve to the main condensers. The dirty steam auxiliaries are definitely segregated from the high-pressure circuit. The arrangement was conceived as a practical means of obtaining the degree of security necessary in these installations, and, in fact, occupies a pivotal position in the general design.

Up to the present the "Duchesses"—"Bedford" and "Atholl"—have each made six Atlantic voyages, a distance of 34,000 miles.

The ordinary watch-keeping duties, such as regulation of feed water, have involved no special effort on the part of the engine-room staff, and this has been confirmed by indirect inquiries made to elicit the general opinion of the junior *personnel*. In fact, there are no features arising out of the use of high-pressure superheated steam in association with the water-tube boilers which have occasioned the senior or junior engineers any concern. The temperature of the boiler-rooms and machinery spaces leaves nothing to be desired.

Three or four main steam pipe joints have shown slight leaks; these were re-made, and no further trouble experienced. For success in this respect ample elasticity should undoubtedly be provided, preferably in the form of "Aiton" corrugated bends, so as to relieve the flanges of undue stress. It is also desirable to avoid an accumulation of water in the pipe lines, as this promotes temperature differences which are liable to stretch the bolts. With the turbo-generator and turbo-feed pumps taking their supply from the main lines, this is not likely to occur even under "standby" conditions.

The fuel consumption registered on trial has been improved upon due to setting the high-pressure turbines at their net designed clearances, and also attention to detail in various directions. The consumption of fresh water for make-up feed is 35 tons per day—about half the quantity used in earlier vessels of similar power.

The combination of oil-fired water-tube boilers and single-reduction geared turbines is an extremely flexible one, enabling a good spurt of speed to be maintained under favourable weather conditions, thereby overtaking detention due to adverse weather or fog.

Most of the boilers have been opened up after two voyages, but some of them have been steamed for longer periods. A light brown dust deposit, amounting to 20 oz. per boiler, distributed over the interior surfaces, has been removed, revealing the original graphite coating unimpaired. This deposit is ferric oxide, and is probably originating in the steel feed pipes or boiler tubes, or both. There is room for some improvement in the de-aeration of the feed water, and other corrective measures are being applied with the object of reducing or eliminating the oxide dust. There is a fair expectation that it will be possible to steam these boilers for six months without brushing the internal surfaces. The total expenses for cleaning the water side of the boilers have averaged about £10 per voyage, as compared with £25 in vessels of 12,000 S.H.P.—based on the same port, having ten single-ended Scotch boilers, five of which are cleaned every voyage.

Altogether the installations give every indication of a high standard of reliability being attained on extremely low maintenance charges.

In view of the general conclusions reached by Sir John Biles in his 1925 paper, reference may be made here to the economics of high-pressure steamships and motor ships of this character. At the time the contract for the "Duchess of Bedford" was placed prices were taken from leading shipbuilders for quadruple-screw Diesel installations. The quotations showed that the cost of a motor ship of similar capacity would have been £100,000 more. On the basis of 15 per cent. for interest, depreciation and insurance, this represents an annual charge of £15,000. Now, in comparisons which have hitherto been made there has always been a good deal of difference of opinion as to the relative cost of boiler and Diesel oils; the cost of repairs is also an awkward factor in such calculations. The writer then proceeds to examine this rather closely. Taking the consumption for all purposes at 18,000 S.H.P. as 0·63 lb. of oil per S.H.P.-hour for steam and 0·48 lb. for Diesel and the consumption for all purposes at 30,000 S.H.P. as 0·60 lb. per S.H.P.-hour for steam and 0·48 lb. for Diesel, it is shown in Table VIII. that the daily fuel costs are less for steam than for Diesel. In the North Atlantic service, as oil is cheaper at American and Canadian ports than at United Kingdom ports, full bunkers should be taken at the former. In the Pacific service similar remarks apply to Vancouver and Hong Kong. While it is not permissible to quote actual contract prices, the prevailing market rates are quite appropriate for the purpose of comparison.

TABLE VI.—*Boiler Schemes for Different Powers.*

Boiler particulars.	Total heating surface.	Total steam.	Evaporative rating on working boilers (overload power).	Cost.
	Sq. ft.			£
20,000 S.H.P. (overload power), 18,000 S.H.P. (service power).				
Six water-tube boilers, working pressure 350 lb., steam temperature 680 deg. F.	31,200	167,000	5·35	41,400
One S.E. Scotch boiler, saturated (working)	3,000	11,000	3·7	4,000
One S.E. Scotch boiler, saturated (reserve)	3,000	—	—	4,000
				£49,400
Six D.E. Scotch boilers, working pressure 220 lb., steam temperature 620° F...	37,500	202,000	5·38	£48,600
20,000 S.H.P. (overload power), 18,000 S.H.P. (service power).				
Four water-tube boilers, working pressure 350 lb., steam temperature 680° F.	31,200	167,000	5·35	39,000
One S.E. Scotch boiler, saturated (working)	2,000	11,000	5·5	3,000
One S.E. Scotch boiler, saturated (reserve)	2,000	—	—	3,000
				£45,000
Six D.E. Scotch boilers, working pressure 220 lb., steam temperature 620° F.	37,500	202,000	5·38	£48,600
			Saving ..	7½%
33,000 S.H.P. (overload power), 30,000 S.H.P. (service power).				
Six water-tube boilers, working pressure 350 lb., steam temperature 680° F.	51,500	275,000	5·35	62,700
One S.E. Scotch boiler, working pressure 200 lb. (saturated)	3,300	16,000	4·85	4,370
One S.E. Scotch boiler (saturated), reserve	3,300	—	—	4,370
				£71,440
Ten D.E. Scotch boilers, working pressure 220 lb., steam temperature 620° F.	62,500	332,000	5·32	£81,000
			Saving ..	11·5%
66,000 S.H.P. (overload power), 60,000 S.H.P. (service power).				
Nine water-tube boilers, working pressure 350 lb., steam temperature 680° F.	103,500	550,200	5·32	119,700
One S.E. Scotch boiler	3,650	21,000	5·75	4,500
One S.E. Scotch boiler (reserve)	3,650	—	—	4,500
				£128,700
20 D.E. Scotch boilers, working pressure 220 lb., steam temperature 620° F.	125,000	660,000	5·28	£162,000
			Saving ..	20%

TABLE VIII.—*Comparison of Fuel Costs.*

	Boiler oil.	Diesel oil.	Steam.	Diesel.
			Daily fuel costs for 18,000 S.H.P. (Atlantic service).	
	s. d.	s.	£	£
New York ..	31 6	60	192	278
Montreal ..	43 0	70	262	324
			Daily fuel costs for 30,000 S.H.P. (Pacific service).	
Vancouver ..	36 0	46	348	355

Much has been said of the advantage of the smaller weight of bunkers required by the motor ship; it is therefore interesting to examine that aspect of the question. A true comparison should include the combined weight of the propelling machinery, fuel, and feed water. In Table IX. the advantage is again shown to be with steam.

Having dealt with first cost, fuel costs, and weight of bunkers, the only other question of moment is repair expenditure—running and periodical. The sum of £200 per voyage amply covers the running repairs in the "Duchess of Bedford's" installation, which for eleven voyages per annum, representing £2200, to which must be added the cost of the annual overhaul—B.O.T. survey—

a further £2800, amounts to a total of £5000 per annum. Examining the major charges, which conceivably may have to be faced in an installation of this kind—allowing the vessel a life of twenty-five years—and taking an ultra-cautious view of possible replacements, it may be necessary to expend, say, £2000 per annum, which, added to the cost of overhaul and survey, totals £7000 per annum.

The significance of these figures is that the annual charge on the extra first cost of the motor ship, viz., £15,000, is of 2½ per cent. from the gross saving previously indicated.

A comparison between the "Beaverburn" and "Minnedosa" illustrates the fuel rates of two relatively efficient types of steam plant burning coal, as given in Table XI.

The "Beaverburn" cannot, of course, be regarded as a high-pressure installation. With a working pressure of 350 lb. and steam temperature of 700 deg. Fah. the fuel rate would be reduced to 0·94 lb. per S.H.P.-hour. With

Table IX.—*Comparison of Installation Weights.*

	18,000 S.H.P. installation.			30,000 S.H.P. installation.		
	Steam.		Diesel.	Steam.		Diesel.
		Tons.	Tons.		Tons.	Tons.
Machinery complete		2275	3300		3410	5300
Fuel (plus two days' reserve)	(6000 miles)	1910	1465	(14,000 miles)	5730	4570
Feed water	Half passage	250	Nil	Part passage	500	Nil
		4435	4765		9640	9870

sufficient to defray the entire cost of repairs—running and periodical—in the steam installation, with £8000 to spare. As the fuel costs of the steam plant in the two services quoted are not greater than the Diesel, it is not even necessary to inquire what the cost of repairs is in the latter. It may remain as a surplus charge of indeterminate magnitude. As it has been suggested, however, that there are some ports where the difference between the price of Diesel and boiler oil is small, it may be of value to examine the 18,000 S.H.P. case on the basis that the difference is nil. The result is £800 in favour of Diesel engines, but as the cost of lubricating oil for a Diesel installation is certainly in excess of this figure, the cost of repairs may again be ignored.

The "Beaver" Class Cargo Steamers.

Some interest attaches to the performance of the five cargo steamships of the "Beaver" class, as being representative of one aspect of modern coal-burning practice. Commissioned a year ago, they are all twin-screw vessels of about 7000 H.P., with Parsons turbines, working pressure 250 lb., temperature 650 deg. Fah., a proportion of the auxiliary machinery using steam superheated to a temperature of 550 deg. Fah. Three of the vessels have four Yarrow and two single-ended Scotch boilers, the Yarrow boilers being fitted with mechanical stokers of the "Erith-Roe" type. The other two vessels have four Babcock and two Scotch boilers, all hand fired. In each case one Scotch boiler only is in use at sea. Results under comparable weather conditions are given in Table X.

Table X.—*Performance of "Beaver" Class Steamer.*

	Speed, knots.	S.H.P.	Daily consumption A.P. converted to 13,500 B.Th.U.	Daily consumption, tons, actual A.P.	$D^{\frac{2}{3}} V^3$ / S.H.P.	$D^{\frac{2}{3}} V^3$ / Tons/day A.P.	Calorific value of coal.	Remarks.
							B.Th.U.	
"Beaverburn," W.	15·52	6,600	(76·8)	87·0	319	25,000	11,900	Mech. stoker
"Beaverford," W.	15·10	6,500	(77·0) 76·9	81·2	297	23,900	12,800	Mech. stoker
"Beaverbrae," W.	14·90	6,560	(81·4)	80·2	283	23,000	13,700	Hand fired
"Beaverhill," W.	14·50	6,000	(78·1) 79·7	80·0	278	20,500	13,200	Hand fired
"Beaverburn," E.	15·0	6,400	(74·7)	77·0	322	27,000	13,100	Mech. stoker
"Beaverford," E.	15·2	6,370	(76·0) 75·0	84·8	330	24,300	12,100	Mech. stoker
"Beaverbrae," E.	14·9	6,480	(81·3)	80·1	298	24,200	13,700	Hand fired
"Beaverhill," E.	14·8	6,188	(83·4) 82·0	84·0	320	23,600	13,620	Hand fired

These installations were designed to give consumption rates of 1·1 lb. and 1·15 lb. of coal per S.H.P.-hour—all purposes—in the stoker and hand-fired jobs respectively, on a fuel calorific value of 13,500 B.Th.U. Both rates were comfortably realised on the official trials, and have been maintained on service. On trial, boiler efficiencies of 82 per cent. and 75 per cent. were obtained with the stoker and hand firing respectively. On service, coal varying in calorific value between 11,000 and 13,000 B.Th.U. has been burned on the "Erith" stokers, whereas good quality bunker coal of 13,500–14,000 B.Th.U. has been used in the hand-fired jobs.

It will be observed that when the consumptions are corrected to a uniform basis of 13,500 B.Th.U. the mechanically fired vessels show a higher average efficiency of 9 per cent. and have registered a higher average speed. The mechanical stokers, which are supplied with air pre-

Table XI.—*Comparison of Vessels "Beaverburn" and "Minnedosa."*

	Type of machinery.	Boilers.	Thermal condition at engines.			Rate per S.H.P. hour (propulsion).	Calorific value of fuel.	Boiler efficiency in service.
			Pressure.	Temp.	Vacuum.			
				Degrees.	Inches.			Per cent.
"Beaverburn" (S.H.P. = 6,600)	S.R. turbines, steam auxiliaries	Water-tube with mechanical stokers and Scotch boilers, hand fired	235	630	29	1·03	13,500	80
"Minnedosa" (S.H.P. = 11,500)	Reciprocating engines and L.P. turbine (direct drive), steam auxiliaries	Scotch boilers, hand fired	208	530	29	1·08	13,500	74

heated to 310 deg. Fah., have given satisfaction. The total maintenance charges are less than 1d. per ton of coal burned.

The coal as fed to the stokers has to be less than 2in. cube, and supplies are arranged accordingly. In services where this can be conveniently done the use of mechanical stokers is advantageous. The charges on their first cost amount to 5d. per ton of coal burned plus 1d. for maintenance, representing, with coal at 20s. per ton, a deduction

oil of 19,000 B.Th.U. calorific value and a boiler efficiency of 85 per cent. this figure would be about 0·63 lb. for propulsion.

Now, a large number of modern cargo and intermediate vessels fall into two classes, viz., single-screw ships of 4000 to 6000 S.H.P. and twin-screw ships of 7000 to 10,000 S.H.P. The fuel rate of 0·63 lb. per S.H.P.-hour for "Propulsion," which does not, in this class of vessel, differ sensibly from the "All purposes" figure, may be taken as applicable to both types. Considering this in relation to a Diesel installation, it is thus shown for a twin-screw cargo vessel of 7000 S.H.P., output speed 15 knots, and a bunkering radius of 10,000 miles that, taking a Diesel oil fuel rate of 0·42 lb. per S.H.P.-hour for propulsion only, the costs of the fuel for the motor vessel works out at £4850 cheaper than the steamer. This saving, however, is discounted by the amount of £4500, which must be allowed for the interest and depreciation on the difference in first cost on the 7000 S.H.P. example taken.

Putting aside for the moment the question of burning coal in the steamships, the following facts emerge :—

If the economics of high-pressure steamships and motor ships of the twin-screw, 7000 S.H.P., 15-knot class be fully explored, it will be found that in the majority of cases the advantage lies with the former, this condition holding when the steamship is using oil as fuel, the extra cost of boiler oil per annum only being slightly in excess of the annual charge on the higher cost of the motor ship. It is evident, therefore, that if the steamship is also able to use coal in zones where its price is attractive, a strong

superiority obtains with that type of installation.

It would therefore remain for the naval architect to design such ships so that a deep tank might be utilised for coal or cargo and double-bottom tanks for oil or ballast, and for the engineer to initiate suitable stokehold arrangements, enabling pulverised coal or oil to be used alternatively and in a manner compatible with safety. The difficulties of this may be considerable; nevertheless, it is thought that they are susceptible of solution.

The future of steam propulsion is bound up with further advances in thermal efficiency and reductions in the first cost of the steamship. On the basis of our experience to date there does not seem to be reason to anticipate any practical difficulty with pressures of 500–600 lb., and temperatures of 750 deg. Fah., but progress towards these conditions would naturally come first in smaller ships. If power station practice is stabilised at or about 1000 lb.

may be expected to yield consumption rates of the order of 0·5 lb. of oil for "Propulsion" and 0·55 lb. for "All purposes" in high-power installations. If the most is to be made of the inherent merits of steam propulsion, the sum total of the advantages must be grasped, as expressed in low first cost, minimum weight of machinery and bunkers, minimum fuel cost—with choice of pulverised coal or oil—and, finally, low maintenance charges. There appears to be a movement towards higher speeds both in cargo and passenger services, and this will, in many instances, be accompanied by the use of larger vessels. The power of the propelling machinery will advance commensurately, and, all circumstances considered, high-pressure steam propulsion may be expected to occupy a predominant position.

In an appendix various points in the paper are expanded and the following table of boiler weights may be given:

Items.	"Empress of Australia." (Double-ended S.B., 220 lb. working pressure, 620° F. temperature, heating surface 6250 sq. ft., oil basis.)	Water-tube boiler. (350 lb. working pressure, 680° F. temperature, heating surface 5200 sq. ft.)
Total weight ex water, tons	130	73
Weight of water	49½	7
Working weight	179½	80
	Weight ÷ tons	Weight ÷ tons
Steel generator pressure parts	95·00	24·50
Superheater	3·00	5·60
Air heater	10·00	13·50
Light steel work	Smoke-boxes and uptakes to base of funnel	All boiler casings and uptakes to base of funnel
	10·00	12·80
Brickwork	1·50	13·10
Mountings	2·50	1·00
Lagging	4·00	2·50
Furnace fronts	4·00	included in casings
	130·00	73·00

In view of the fact that important deductions are based on the relative prices of a Scotch and water-tube boiler of similar capacity, it is thought expedient to show the weights of the two types in greater detail in order that the features of each may be properly focused.

Opinion differs as to the durability of Scotch and water-tube boilers. This is a matter which can best be dealt with by discussion, but comparison should, of course, be made between up-to-date examples of each.

SIXTY YEARS AGO.

Following our notice in last week's issue on the development of the velocipede, we may note that in our issue of March 26th, 1869, we recorded the result of a 2-mile velocipede race in Clapham Park. Three gentlemen competed in it, and after a very spirited contest Mr. Vonrio won by several lengths. The 2 miles of roadway were covered in 10¼ minutes, the first mile taking 5 minutes 42 seconds, and the second, on which a slight descent favoured the riders, in 4 minutes 48 seconds. Interest in the velocipede was developing rapidly. The inhabitants of Chester had, we read in the same issue, received "quite a sensation" from the arrival in their midst of seven velocipedes which were to take part in a forthcoming race from Chester to Birkenhead. . . . Sixty years ago Euston Station was already old—thirty years old, to be exact. With its "stupendous carriage entrance" and its stately vestibule it was regarded as a notable feature in London's architecture, although close at hand the Midland Company's St. Pancras Station, then just completed, provided, in the opinion of many, a strong rival. In the issue named we published an article on Euston, one of a series dealing with London's railway termini. The fine entrance to Euston was, we said, like "a jewel in a swine's snout." It stood amid mean dram shops and lodging houses, and from no angle of approach could it be seen to advantage. The position in this respect was, however, shortly to be improved, for the company was seeking parliamentary powers to cut a wide street from the archway to Euston-road. The traffic from Euston Station was, we noted, of an exceptional character. It handled fewer trains per day than any other London terminus, a circumstance explained by the fact that the London and North-Western was pre-eminently a "long-traffic" line and had little suburban traffic to deal with at Euston. Twenty-five trains of all kinds, we noted, left Euston each day and a similar number arrived. The first train left at 6.15 a.m. and the last at 9.20 p.m. The average receipt from bookings at the station was from 19s. to 20s. During a recent month the average had exceeded 20s., a total of £55,000 having been received from 53,000 passengers. We noted, as illustrating "the rapacity with which local authorities are prone to regard railway companies in the matter of rates," that the archway and lodges at the entrance to Euston, erected at a cost of about £80,000, had been assessed at the annual value of £4600. The whole station covered an area of 6 acres, out of a total of 600 within the district administered by the local authorities. Yet for watching, paving and lighting the company had to pay an eighth of the total rates for the district, in spite of the fact that it watched, paved and lit its premises at its own cost.

A record was established last year by the Montreal Harbour Commission in the amount of new work undertaken. During the year about 2250ft. of new wharf were laid down, the greatest amount of this class of work ever accomplished in any one season in the history of the port. For it twenty cribs were sunk in the harbour by contractors under the supervision of the harbour engineering staff.

A Large Turbine-driven Direct-current Generator.

MODERN central station practice being entirely concerned with the generation of alternating current, such direct current as is supplied in the area served has to be produced by rotary converters, motor generators or rectifiers, situated usually on the consumers' premises. The converting machinery has, as a rule, to be installed at the expense of the consumer, who moreover must bear its operating costs and conversion losses. It is evident, therefore, that industrial works needing large quantities of direct-current will usually find it more advantageous to generate for themselves, as not only are all costs of transmission and conversion thereby saved, but the works are free from the restrictive clauses of power contracts and from the happenings on a system outside their own control. The field for turbo-driven generating units was seen to be sufficiently large by C. A. Parsons and Co., Ltd., of Newcastle-on-Tyne, to justify them in developing machines to meet the demand, and they have equipped the private power plant of a large alkali works in the North of England with no less than 36,000 kW of geared turbines for driving direct-current generators.

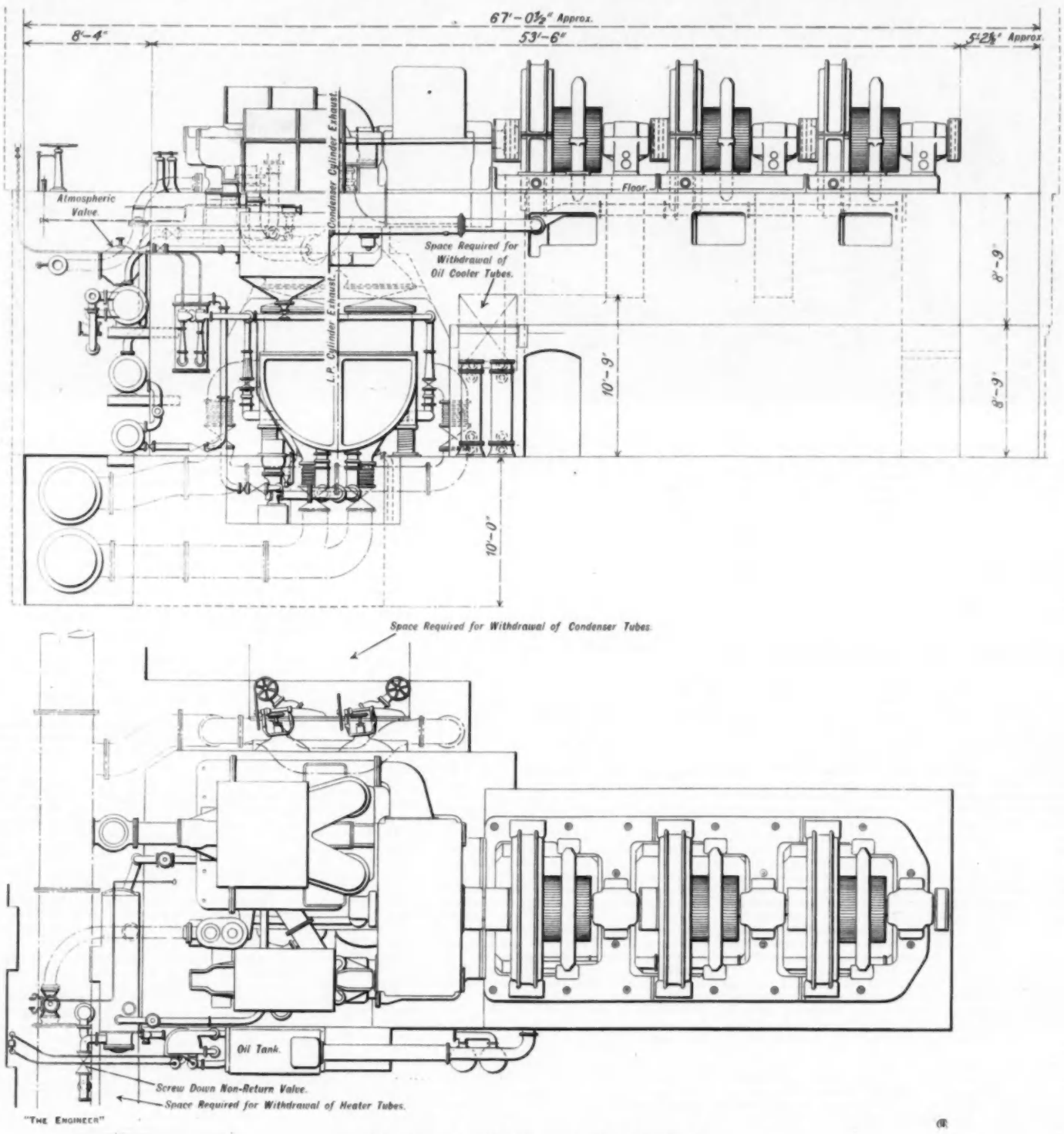
A photograph of one of the last two units installed is reproduced on page 364, drawings of the set being given above. These two units, which were manufactured throughout by C. A. Parsons and Co., are each capable of developing 6000 kW. Each unit consists of a two-cylinder steam turbine connected by reduction gearing to three 2000 kW direct-current generators in line, and complete with condenser and auxiliaries. The high pressure portion of the turbine runs at 6000 revolutions per minute, the low pressure portion at 3600 revolutions, and the three dynamos at 375 revolutions per minute. Steam is supplied to the turbine stop valve at a pressure of 550 lb. per square inch gauge, and at a temperature of 750 deg. Fah. The turbine is bled at two points for feed-heating, steam being taken from the low-pressure cylinder at a pressure of about 15 lb. absolute, and from the high-pressure exhaust at about 52 lb. absolute. By this means the condensate is heated regeneratively to 250 deg. Fah.

Both turbine rotors are machined from solid forgings, and the heights of the successive blade rows are so graded as to give a steam passage of true conical form, without steps, which would interfere with the smoothness of the steam flow and cause losses by eddying. The blading is of the "end-tightened" type, giving large radial clearances throughout the high-pressure part of the turbine, and similar blading is used for the low-pressure part except for the last five rows, which are of the usual type. The turbine throttle valve is controlled by an oil-pressure relay, the pressure being provided by an oil pump driven from the high-pressure rotor. An emergency valve is also fitted in the main steam pipe, this valve being actuated by a runaway governor mounted on the end of each of the turbine rotors. The gearing between the turbines and the line of dynamos is of the single-reduction pattern with double helical teeth.

The condenser is of the surface type, but is of special design owing to local conditions. The circulating water, which is of an acid nature, affects the tubes, and means had to be provided to enable the plant to be kept running with one half of the condenser out of action for the replacement of tubes. To meet this requirement the condenser is built practically in the form of two separate condensers in a single shell, each having a separate steam inlet controlled by a valve. Half of the total condensing surface can thus be put out of action, the turbine running on the other half for the time being. Air is extracted by a two-stage steam jet ejector connected to both parts of the condenser by a branched pipe, so that either part can be isolated at will. The steam from the primary jet of the ejector is condensed in an auxiliary condenser, while that from the secondary jet gives up its heat in a feed-water heater. The condensate is dealt with by a centrifugal extraction pump.

The electrical portion of the plant, consists, as has been mentioned, of three dynamos, each having a maximum continuous rating of 2000 kW. They are mechanically coupled in line and electrically coupled in parallel with each other. The output is from 8333 to 7700 ampères per machine at a pressure from 230 to 260 volts. The generators are shunt wound and fitted with interpoles, all windings being thoroughly impregnated in vacuum ovens before assembly. A special feature of the machines is the accessibility of the brush-gear, which is carried from a separate yoke encircling the centre of each accumulator. The design renders the examination and adjustment of any of the brushes perfectly easy while the machine is running.

The whole plant is of thoroughly modern design, as the steam conditions indicate, and is of a very high efficiency. It does not, however, stand alone by any means, as an example of Messrs. Parsons' enterprise in the development of direct-current turbo-driven generators. There has, for example, been recently completed and tested at the Heaton Works a special 5000 kW unit, comprising a

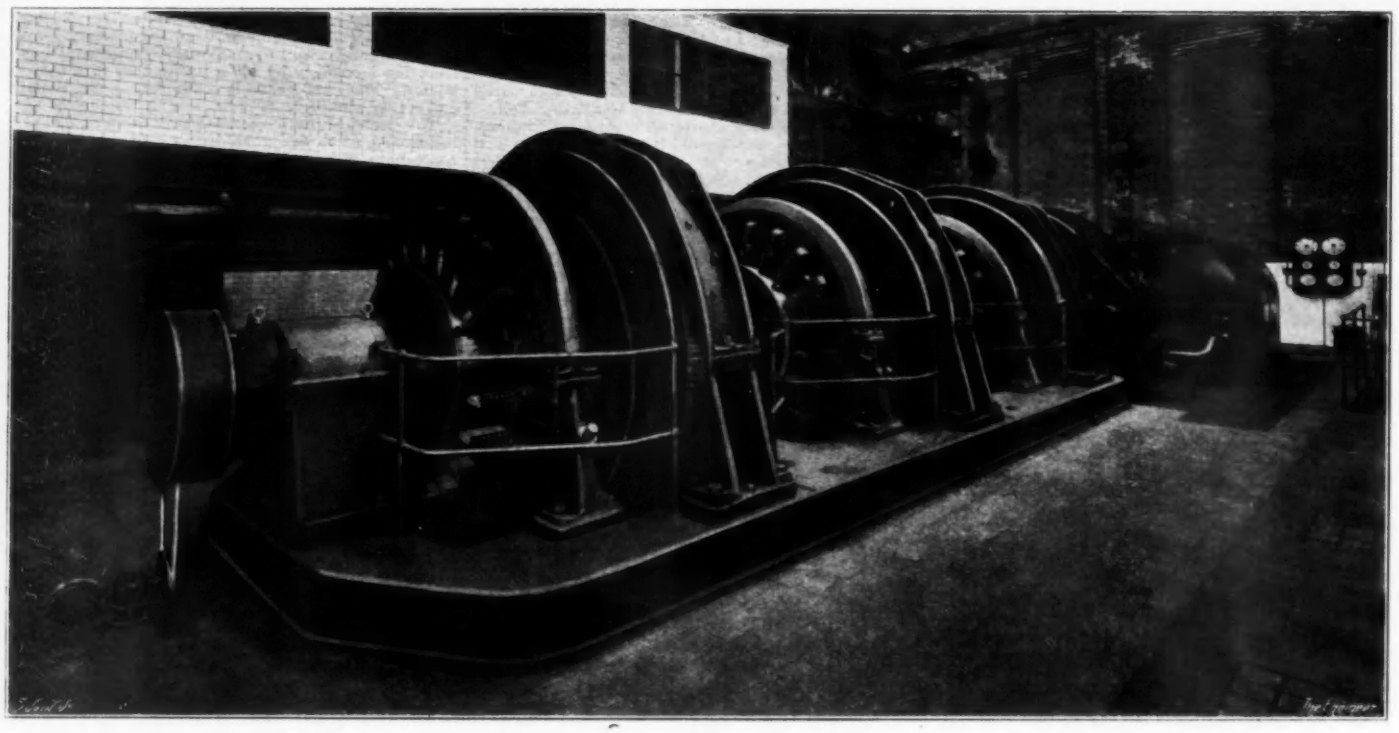


6000 kW DIRECT-CURRENT TURBO-GENERATOR

6000 KILOWATT DIRECT-CURRENT TURBO-GENERATOR

C. A. PARSONS AND CO., LTD., NEWCASTLE-UPON-TYNE, ENGINEERS

(*For description see page 363*)



single-cylinder steam turbine designed to pass out steam at three stages, driving both direct and alternating-current machinery. The turbine is directly coupled to a 3000 kW three-phase alternator, which it drives at 3000 revolutions per minute, and the end of the alternator shaft is coupled to reduction gearing, the low speed shaft of which drives a 3000 kW direct-current generator at 500 revolutions per minute and also the exciter for the alternator. The dynamo generates 6250 ampères at a pressure of 460 volts, and is believed to be the largest continuous current dynamo at that speed ever built.

Institution of Chemical Engineers.

AT the annual general meeting of the Institution of Chemical Engineers, held at Grosvenor House, Park-lane, London, on Wednesday, March 20th, Mr. J. Arthur Reavell was elected President ; and Sir Alexander Gibb (the retiring President) delivered a presidential address on "The Co-ordination of Engineering Institutions and Societies." It is obvious, he said, that there is a considerable wastage of effort, and a retardation of progress, caused by the almost haphazard dissemination of scientific effort in general, and engineering effort in particular, over the growing multitude of technical institutions and societies that now exists. So far as such societies were devoted to the promotion of the science of engineering, the overlapping and competition must inevitably in many ways hamper the attainment of the object. But there was a need—a very definite and indisputable need—for most if not all of those societies, and the value of small and specialised technical institutions was not always fully appreciated by the older and larger Institutions. The problem, therefore, was not the reduction of the number of existing technical institutions and the prevention of further increase, but to find the best way to satisfy the different individual interests and at the same time secure all the advantages that lay in co-operation. At the moment, there were in this country more than one hundred institutions, institutes, societies and associations devoted more or less directly to the science, subject and practice of engineering, and there would be general agreement on the advantages to be gained from the greater concentration of their activities. These advantages were, in the first place, an economy in actual expenditure on the provision of housing, libraries, records and other facilities ; secondly, the consolidation of professional interests and the improvement generally of the status of properly qualified engineers in the eyes of the world at large ; thirdly, the provision of effective means of securing for the engineering profession the influence that it should have when political, departmental or other interests threatened it ; fourthly, the prevention of overlapping in intellectual effort and the co-ordination of scientific study and research ; and lastly, and really the most important—seeing that it is the chief reason and justification for the existence of all engineering institutions—the protection of the public from unqualified persons.

A great deal of thought had, continued Sir Alexander, been given to the question by many able minds, and efforts have been made for many years past to find a complete answer. He proposed, therefore, to summarise what had been and was being done not only in this country but throughout the world, for although Great Britain was the first in the engineering world, it was by no means the only country where the problem was acute.

Taking our own country first, the problem had been approached in a number of different ways, among them :—Amalgamation ; affiliation ; the establishment of joint councils ; the grouping of kindred societies in one building and general co-ordination by registration or otherwise. Amalgamation was the obvious remedy proposed by the critic who had not studied the problem very closely, but it was not and never would be a solution.

Affiliation was in some ways a more nebulous form of amalgamation. It had for many years been pressed with great enthusiasm by some as the only statesmanlike course to be adopted, and one of the oldest and largest engineering institutions laid certain proposals before the Institution of Chemical Engineers some while ago. At that time nothing eventuated, and it was found impossible to find a *modus vivendi* or formula that would meet the views of all parties. There appeared to be a lack of agreement, not so much as to what was desirable but rather as to what was really involved in the proposal. There was considerable doubt what the term "affiliation" really connoted, and, while there was in the mind of the authors some sort of idea analogous to that claimed to operate in our Empire—the Institution at any rate was unable to accept the idea of daughter and mother Institutions, and in fact rejected the term "affiliation" altogether. The possibilities of the suggestion had yet to be fully explored, and it had been suggested that "federation" rather than "affiliation" was the proper line to adopt.

As to the establishment of joint councils, the only such council of whose working he could speak with any authority was the Engineering Joint Council. It had been in existence nearly seven years, but it could not be said that it had obtained more than a very partial success. Membership in the first place was in practice limited to the four founder Institutions, the Civil, Mechanical and Electrical Engineers and the Naval Architects, with only one addition, and the Council was definitely debarred from executive power or any initiative of discussions.

The grouping of kindred institutions into one building was obviously, apart altogether from other and wider considerations, a very sensible and profitable policy. It had been done in America, notably in the engineering building in New York, where all the important engineering institutions were housed together and shared the library, information bureau, lecture halls and other facilities. He understood that there was an important project on foot to unite the more important mining, fuel and metallurgical institutions in one large building. The prospects seem distinctly fair, as the principle had been agreed to by all concerned, and he hoped it would go through, for he could see nothing but good in the proposal.

One of the principal objects of co-ordination, namely, the improvement of the status of engineering, was in America secured, or at least attempted, very largely by the registration of engineers. Statutes directing either compulsory or voluntary registration of engineers existed in twenty-five out of the forty-eight States, practically the whole of that legislature having been enacted during the last twelve years. Action on similar lines had been taken in most of the Provinces of Canada, and in Quebec the results had been that engineering was practically a closed corporation. The qualifications necessary for registration appeared on paper at least to be high, but it was easy to see the many grave disadvantages that would or might be found to exist in any scheme of general registration at least in our less bureaucratic country.

In view of the forthcoming Engineering World Conference at Tokio, it might not be out of place to give some details of that unique body the Kogakkai, which was to act as host on that occasion. The Kogakkai was the original engineering institution in Japan. Intended like our own Institution of Civil Engineers to cover all engineering activities, it was threatened in course of time by the increase of specialising in engineering. In the first instance it endeavoured to meet the demand by the establishment of branches or departments to cover the various interests. But in spite of that, institutions began to be formed to meet the requirements of mechanical, electrical, chemical, marine engineers, and so on ; and members of the Kogakkai found themselves forced, if they were to keep abreast with the latest developments, to join whichever new societies dealt more particularly with their own special interests. The position of the Kogakkai was thus much weakened, because in that frugal country engineers were reluctant to pay subscriptions to two societies. The difficulty was eventually solved by the Kogakkai some ten years ago closing its membership entirely so far as individual members were concerned, and becoming an institution of twelve members composed of the twelve Presidents for the time being of the twelve major societies.

The Kogakkai now acted as the nominal head and representative of engineering in Japan, whether in relations with the Government ; in regard to any proposad legislation affecting the interests of engineering generally or individual societies ; or in a social way. The personal opinion of such Japanese engineers as he had discussed the matter with, however, seemed to indicate that the influence of the Kogakkai was definitely waning, but it was probably too early to say what the ultimate development is likely to be.

Summing up, Sir Alexander said that our first conclusion must be that there was no single solution of the problem. The lines on which action might most profitably be taken would seem to be :—

(1) The grouping of kindred societies, *pari passu*, with the elimination by amalgamation of some of the weaker societies for whose separate existence there seemed to be no justification. That grouping would not necessarily imply a physical grouping.

The conjoint publication of Proceedings of kindred societies, which was an excellent suggestion that had been put forward, might be one line of approach.

(2) The evolution by slow degrees of councils representing the major engineering societies and the several groups of societies, with eventually perhaps a General Engineering Council.

It was possible that some form of general co-ordination for research work alone could also be worked out without great difficulty. The good work done by the Conjoint Board of Scientific Societies, which was established during the war under the ægis of the Royal Society, justified one in the hope that, eventually, something on the same lines might be done by engineering institutions. In fact, to some extent it was already being done in, for instance, the Marine Oil Engine Trials Committee, set up jointly by the Institution of Mechanical Engineers, the Institution of Naval Architects, and the Institute of Marine Engineers.

IN a paper on "Central Heating Systems," read before the Institution of Engineers-in-Charge, Mr. W. E. Fretwell explained that the fundamental difference between warming by means of the ordinary hot water radiator of the vertical column type and the low-temperature radiant heat method is that the former warms the room mainly by the distribution of convection currents of heated air, whilst the latter raises the temperature of the interior room surfaces and contained objects by the direct application of radiant heat there to. The radiant heat idea is to warm the air as little as possible. The temperature of the air of a room warmed by low-temperature radiation does not vary by more than 3 deg. at various distances from the element. Radiant heat rays pass through the air undiminished in quantity and only become converted to heat upon striking the fabric and occupants of the room, which, in turn, serve as heat distributors. It is claimed that a room warmed by radiant heat elements is comfortable at a lower air temperature than obtains when the room is warmed by the ordinary type of radiator.

Provincial Letters.

THE MIDLANDS AND STAFFORDSHIRE.

(From our own Correspondent.)

End of Quarter.

WITH the approach of the Easter vacation business has declined somewhat in the Midlands and Staffordshire, and less interest is displayed in iron and steel. This week's market was only moderately attended, consumers' requirements being small. Taken as a whole, Midland industrialists have no great grounds for complaint, and most of them appeared fairly satisfied with the volume of business done and the manner in which it had developed during the past three months. They are hoping, however, for much better times in the next quarter despite the upsets which are bound to affect the normal course of trade. The improvement in the basic industries of South Staffordshire appears to have established itself and, judging by the inquiries circulating at recent meetings of the trade in this area, a fairly active demand should be experienced next quarter. Many of the local works will be idle during a portion of next week, but a good proportion of them will resume with reasonably satisfactory order books.

The Pig Iron Situation.

The recent development with regard to pig iron control holds the main attention of industrialists in this area. Such a bold effort to re-establish the Midland pig iron industry had hardly been foreseen, and the manner in which it has been taken up by furnacemen has come as something of a shock to consumers of this material. When the movement was started two months ago and an advance of half-a-crown per ton in prices was announced, it was openly boasted by buyers that the smelters would be unable to enforce their demand, chiefly through the lack of unison. The roping in of interests which, up to that point, had remained outside the conversations and conferences, changed the whole complexion of the position, and furnacemen took the whip hand and successfully upheld the new selling rates. With agreement established between the various smelting interests, proposals for a constructive scheme of control were considered, and a scheme—at present regarded as tentative—was decided upon. The scheme does not involve the pooling of interests, nor does it directly regulate output, the basis being price control, with certain measures for relieving internal competition. At the commencement, the previously declared prices for No. 3 foundry pig are taken as a standard—£3 2s. 6d. for Derbyshire, and £2 19s. for Northamptonshire makes, at furnaces. A fixed scale in relation to these rates is laid down. No. 1 foundry is to be 4s. above No. 3, the extra for No. 2 is 2s., while No. 4 will be 1s. less than the basis rate. All makes of forge quality are to be uniformly 4s. below the price of No. 3 foundry. "Silky" is to be the same as No. 3. White and mottled pig are to be free. In order to regulate prices effectively, the supply area has been divided into a number of zones within each of which the scale will apply uniformly. To achieve this the practice which has hitherto obtained of quoting prices on rail at furnaces is superseded by prices for delivery at buyer's station or at his works, as the case may be. Thus the prices for delivery in 10-ton lots and upwards at Black Country stations are £3 15s. for Staffordshire No. 3 foundry, £3 12s. 6d. for Derbyshire, and £3 9s. for Northamptonshire, with additions or subtractions for other grades and for forge iron, according to the scale set forth above. For delivery into the works the price is increased by 7d. per ton. An important part of the control which it is sought to establish is directed to the operations of the merchant. The old relationship of producer and merchant is held to be incompatible with price control. Merchants have received an intimation that from now forward a fixed commission of 9d. per ton will be allowed to them on their purchases. In other respects they will be on the same footing as the rest of the customers. The districts which have undertaken to give a trial to the scheme are Lancashire and South Yorkshire, Derbyshire, Leicestershire, Nottinghamshire, Northamptonshire, Lincolnshire and North Staffordshire. There are between 120 and 130 blast-furnaces in that radius, a large proportion of them devoted to the production of the classes of pig iron to which the control applies; but not half the furnaces are in operation. The new organisation will for the first time voice the policy of the body of Midland blast-furnacemen, and will presumably negotiate with the coke suppliers as occasion demands. The scheme, it should be pointed out, does not apply to exports or to any trade outside the radius. Northamptonshire and Derbyshire furnacemen state they are booking a certain amount of business on the new terms. Consumers, on the other hand, maintain that business is at a standstill, and that smelters have overstepped the mark. Producers argue that the flow of orders is only temporarily arrested, and that consumptive demand will dictate the pace as contracts are worked off. The position is being closely watched by both sides, and consumers are, in the majority of cases, running their plants as far as possible on iron bought at the more favourable rates prevailing before the control became effective.

Scarcity of Coke.

The scarcity of supplies of blast-furnace coke is causing Midland furnacemen considerable anxiety. It is evident that, at the moment, there is insufficient to meet the demand. A furnace in Nottingham was put out last week owing to the inability to secure supplies, and at least one furnace in Northampton has been on slack blast. Supplies will have to be much heavier before any question of relighting furnaces can be considered in the Midlands. Many coking plants have been modernised, and the general level of efficiency has been raised, but employment for them has been so unsatisfactory that output has been greatly reduced. Coke, such as sold for 12s. 6d. or 13s. on rail at the beginning of the year cannot be got now at half-a-crown higher. Dearer coke means dearer iron and steel, in fact a wide range of metal products is affected.

Steel Prices.

Demand for finished steel varies little, and no great amount of interest is displayed in this branch of the market. Constructional engineers, and other users of this material, are however keeping a weather-eye on prices. There is some speculation as to the view which will prevail in the councils of the steelmakers on the question of future prices. Under the rebate scheme values have remained stationary for over a year. It is evident some of the makers think the time has come to increase them. Such a step would, needless to say, be far from welcome by users. These latter assert that contracts are accepted at such low margins of profit that any advance in steel prices would land them in a very difficult position. They are hoping for greatly increased activity during the second quarter of the year, and this business would be encouraged, they say, if steelmasters see fit to reaffirm recent structural steel prices. In the half-product branch prices are still hardening. The upward movement of prices has kept pace latterly with advances in the cost of foreign material. Welsh steel bars have been advanced by 3s. 9d., making the basis £6 6s. 3d. In small steel bars the stiffening tendency continues, largely as the result of the better order books held by makers, the increase in semis and the decrease of continental competition. Selling prices range from £8 2s. 6d. to £8 5s.; even more than this is reported to have been quoted in isolated cases. The new plan for restricting output by definite percentage quotas is resulting in some stringency in the black plate section. A quiet business is passing in tin-plates at 18s.

Staffordshire Iron.

Fair activity prevails in the Staffordshire wrought iron industry. The cost of raw materials is going up, and the increase in pig iron will mean a considerable difference to the ironmaster's bill when he comes to order fresh supplies. The rise is considered inconsistent with the facts of the situation, and where possible business in forge as well as foundry pig is being withheld. Marked bar prices stand at £12, a figure which has prevailed for nearly a year. The market is not responsive to attempts to stiffen prices of Crown bars, though irregularities are less marked than formerly. With Belgian No. 3 bars obtainable at £7 5s., delivered into the Black Country, there is no scope for Staffordshire rollers in the nut and bolt and hurdle making industries. Lancashire mills now require £9 10s. for common bars, and £10 10s. in their own area for Crown, prices which mean cessation of competition in this district. Ironmasters are hopeful that the rising production costs on the Continent will help the local trade to regain its former prosperity. The inward flow of continental iron has been considerably reduced. Belgian No. 3 iron is still, however, a factor greatly operating against local makers of common iron. Values of wrought iron gas tube strip remain firm, with an upward tendency. Sellers now require £10 15s. as a minimum, and consumers are stated to have paid as high as £11 for small tonnages, delivery of which was urgently required. Only in such special cases, however, does this latter figure appear to have been obtained.

Sheets.

A little more interest was displayed in galvanised sheets at the weekly meeting of the Midland iron trade in Birmingham this week, but there was no marked improvement in demand, either from home or foreign sources. Inquiries lead one to the conclusion that a return of activity in this department of the market may be looked for in the near future. Galvanised corrugated sheets of 24-gauge continue to be quoted round about £13 10s., but business would be accepted by some mills at half-a-crown below this figure. The call for lighter gauges has also fallen away though not to such a marked extent. Black sheets are in good request, and values are maintained at recent levels.

Ironfounders' Difficulties.

Black Country ironfounders complain just now of the very unsatisfactory conditions ruling in the trade. Raw material costs have increased appreciably, without any sufficient increase in the volume of business to balance the effect on production charges generally. Moreover, there is a considerable amount of unemployed capacity, and as a result competition for orders is so keen that prices of engineering castings are being further pared, in some cases, notwithstanding rising costs. Profits at current selling rates it is maintained are almost non-existent, yet it would be practically impossible to increase the price of the products. Many would much like to be able to foresee the outcome of this difficult position.

New Works.

Industrially Wolverhampton continues to develop and new works of considerable magnitude have recently been established in the district, as reported in these columns from time to time. Now comes the news that another large company has purchased a site of nearly three acres for the construction of works. The identity of the firm is not yet known, but the directors have visited the Wolverhampton Industrial Development Association, and have given them to understand that orders for the steel required for constructional work will be placed locally. Negotiations are proceeding with a railway company for the provision of a siding for the new concern, and a large number of hands is expected to be employed in and about the works. There is, it is understood, a prospect of a further firm establishing itself in the town. If that should develop, as it is hoped it will, work would be found for some 5000 hands.

Unemployment.

The number of unemployed in the Midland area continues to decline in a most satisfactory manner. In the current return there is a drop of 17,568, which follows a decrease of 22,947 in the previous total, and makes a decrease of 40,515 in a fortnight. Birmingham's figure this week is less by 2535 than it was in last week's return, and, covering a fortnight, is down by 5581. Every town in the official list records a decrease, which is a rather unusual feature of the return. Of the total unemployed 108,152 are men, 32,729 women, 2360 boys, and 2796 girls.

LANCASHIRE.

(From our own Correspondents.)

MANCHESTER.

Another Colliery Merger.

EARLY in the present month a £7,000,000 company—Manchester Collieries, Ltd.—was registered to take over the colliery and allied business carried on by Fletcher, Burrows and Co., Andrew Knowles and Sons, Andrew Knowles Wharves, Ltd., the Clifton and Kersley Coal Company, the Pilkington Colliery Company, Outwood Collieries, Ltd., Collieries (Clifton and Kersley), Ltd., John Speakman and Sons, Bridgewater Collieries, Ltd., Bridgewater Wharves, Ltd., and Astley and Tyldesley Collieries, Ltd., all of which are concerns the areas of operation of which are in South-East Lancashire. A similar scheme of amalgamation, though on a less important scale, is being developed in the St. Helens district, in South-West Lancashire. The pits embraced in the merger are the St. Helens Colliery, the Haydock Colliery, Sutton Manor, Sutton Heath, Lea Green, Sherdley, Collins Green, and Ashton's Green collieries, virtually all the coal-producing concerns in the area being affected. Up to the present no mention has been made of the Clock Face Collieries at St. Helens, which are owned by the Wigan Coal and Iron Company, Ltd.

Power Station Engineer's Future.

An interesting view of the position of the power station engineer under the new conditions of electricity production was given by Mr. H. C. Lamb, the city electrical engineer of Manchester, at a dinner here on Saturday of the Northern Division of the Electrical Power Engineers' Association. Mr. Lamb's opinion is that the concentration of generation in a few centres instead of in a large number may reduce the number of qualified engineers required in power stations, but that it will inevitably increase the number required on distribution. Already, he said, in the case of some of the largest generating authorities the number of engineers who are employed outside the power stations exceeds the number employed inside, and there is undoubtedly a great demand to-day for engineers possessing sound technical training as a groundwork and the ability to apply that training practically in the commercial, constructional, or operating branches of the industry.

Electric Signals Completed.

The third and final stage of the work of converting the section of the London, Midland and Scottish line between Victoria and Exchange Stations, Manchester, and Ordsall-lane Station, Salford, to electric signals was completed last Sunday. The first day of operations at Exchange Station at the beginning of last week and at Victoria Station at the beginning of the previous week was attended in each case with considerable dislocation of traffic and unprecedented delays to trains. At both stations, however, the new system is now working smoothly.

A £670,000 Tunnel Contract.

Edmund Nuttall, Sons and Co., Ltd., of Trafford Park, Manchester, has entered into another substantial contract in connection with the construction of the tunnel under the river Mersey between Liverpool and Birkenhead. The Joint Committee has now accepted the firm's tender of £670,390 for the construction of the full-sized entrance tunnels on the Liverpool side, a task which the contractors estimate will take just short of two years to complete. Altogether, the tunnel will have cost in the region of £5,000,000.

Liverpool's Power Scheme.

At a cost of £339,000, Liverpool Corporation has acquired the Clarence Dock from the Mersey Docks and Harbour Board, as the site for the construction of a new super-power station.

Cheaper Current for Tramways.

An agreement has been reached between the Electricity Committee and the Tramways Committee of the Bury Corporation, whereby the charges for electricity supplied to the latter body have been reduced from 1·35d. to 1d. a unit.

Plant for Steel Sheets.

The annual report of the directors of John Summers and Sons, Ltd., of Hawarden Bridge Steel Works, near Chester, states that during the past year considerable capital expenditure was incurred in the provision of plant for the production of all grades of steel sheets. The profit for the twelve months was maintained at about the same level as for 1927, and for the fifth year in succession the ordinary shareholders are to receive a dividend of 10 per cent.

Non-ferrous Metals.

Conditions in the non-ferrous metals market during the past week have been less exciting than in the period covered by the notes in this column a week ago. Copper, it is true, is about £1 10s. a ton dearer on balance, but that is a relatively small matter when one bears in mind that the advance in the previous week was one of over £12. Tin, lead, and spelter are all below the high levels last reported, although still dearer than a fortnight ago, appreciably so in the case of lead and spelter. Whether there will be a gradual relapse in copper values or whether the advance will be renewed is, of course, an unknown quantity. The fact remains, however, that industrial users of the metal are faced with very grave difficulties in carrying on business. The movement in the

copper section of the market has continued on a fairly active scale, although below the level of the previous week. Interest in tin has been rather better, but prices have given way a little. Much of the heavy buying in the lead section has been of a speculative nature. Values have been subject to considerable fluctuation, and on balance at the time of writing are lower to the extent of 10s. to £1 a ton. Spelter, also, has been the subject of a fair volume of inquiry, but here again quotations are cheaper by about 10s. a ton.

Iron and Steel.

With pre-Easter quietness influencing the markets here, there has been little of moment to report in respect of iron and steel. Apart from one or two fair-sized orders for pig iron, there has been comparatively little business done in this section, although quotations are very firm, with Staffordshire at 73s. 6d. per ton, Derbyshire at 71s., Cleveland at 80s., Scottish at 90s., and hematite at about 86s. per ton, all delivered to Manchester works. Finished iron meets with a moderate demand, with Lancashire firms quoting Crown quality bars at £10 10s. per ton and seconds at £10. Neither in constructionl steel nor in plates—general or locomotive—has the demand been at all active this week. Virtually, the one bright spot has been in the small bar section. Some rollers have very good order books, and this fact, coupled with the high cost of raw materials, has had a marked strengthening influence on prices, from £8 10s. up to £8 15s. per ton having been quoted for ordinary re-rolled sorts since last report. In other directions prices are maintained, with sections and joists at £7 17s. 6d. per ton, ship and tank plates at £8 12s. 6d., basic boiler plates at £9 12s. 6d., and acid sorts at £9 17s. 6d., and large-diameter bars at £8 17s. 6d. per ton. For foreign products the demand has been by no means extensive, but quotations keep up.

Boiler Examination.

It is reported by the Manchester Steam Users Association that the total number of examinations made during the year was 24,501, of which 10,995 were of the classes known as "Internal," "Flue," and "Entire," with the boilers at rest and prepared, and in accordance with the Association's long-established practice, a detailed report was supplied to the member upon each examination, along with a certificate of safety where this was justifiable, the detailed report being furnished in addition to that required under the Factory and Workshop Act. Faithful and efficient inspection for the prevention of explosion was the guiding principle of the Association's founder, and this has never been allowed to be lost sight of, with the result that the Committee is again able to say with satisfaction that, though the Association has now been established nearly three-quarters of a century, no preventable explosion has occurred of any boiler which has been covered by its guarantee and certificate of safety. Since the publication of its last report, the Association has recorded the occurrence, outside its ranks, of sixty-nine explosions in the United Kingdom. These resulted in the killing of thirteen persons and injury to forty-eight others. Twenty-nine of these explosions, by which six persons were killed, and twelve others injured, may be termed "Boiler explosions proper," while the remaining forty, killing seven persons and injuring thirty-six others, may be termed "Miscellaneous explosions," *i.e.*, those arising from steam pipes, stop valves, kiers, drying cylinders, bakers' ovens, &c.

BARROW-IN-FURNESS.

Hematite.

The position in the hematite pig iron market continues to be satisfactory, and makers are in a better position than they have been for some time. Better prices are ruling and stocks are being reduced very considerably. As a matter of fact, if business continues on present lines stocks will come down to such an extent as to make a greater production necessary. Much depends on the state of the steel trade, as the rail departments are at present fairly heavy users of iron. Continental trade is not heavy, but it is steady. American business is variable. Special qualities of iron continue to be in regular demand, and the output is considerable. The local iron ore mines are slightly busier because of better business with outside buyers. Foreign ore has a steady market. The steel trade is moderate, and although the rail mills are still kept going, fresh orders would be welcome. The hoop mills are better circumstanced.

Shipbuilding.

The order received by Vickers-Armstrongs for a flotilla leader for the British Admiralty was forecast in this letter some time ago. It will provide some work for Barrow, but a few orders for heavy tonnage for the mercantile marine would be welcome. Vickers-Armstrongs will be entrusted shortly with some reconditioning work for the Orient Line.

SHEFFIELD.

(From our own Correspondent.)

Basic Steel Busy.

THE strongest department in local industry continues to be that producing basic steel. The plants are well employed, turning out very considerable quantities of material, for which there is a ready market. Similar activity is well maintained in North Lincolnshire. At the Redbourne Hill Works, which were restarted recently, one blast-furnace, two steel furnaces, and a mill are now operating. Preparations are being made for the starting of another blast-furnace, the output from which will enable more steel to be made. During the past six months foreign competition in basic steel has been more or less negligible, but now German billets are again being offered at prices below local quotations, with a guarantee of quick delivery. One cannot say whether this state of things is merely temporary or is likely to continue, but it is disturbing, as British prices have already gone up by 5s. or more per ton, and even that advance is not sufficient to cover the increased costs of production.

Other Steel Branches.

There has been rather more activity at the local steel works during the past week or so, but this is attributed chiefly to pressure to complete orders and increase stocks of commodities in view of the approach of the Easter holiday. The fundamental position does not show much sign of change. There is a scarcity of inquiries, in regard to both number and weight, and, so far as ordinary steel lines are concerned, orders are chiefly for small quantities. In many cases consumers find that financial conditions compel them to confine their purchases to the needs of the moment. There has been no improvement in the demand for railway material, and much shortage of work is the rule at the tire, axle, and rail plants. A more cheerful story is told of the heavy forges, which are very busy. The recently developed industry of making hollow rolled boiler drums is well employed, there being on hand at the present time more than a hundred of such drums of varying sizes. Brisk business is also reported in special lines, including the provision of many kinds of steel and tools for the motor industry. In many quarters one hears reports that the near approach of the General Election is having a restrictive effect upon trade.

Increased Prices.

The increase in the price of basic steel, already referred to, is not the only one which has taken place in this district; in fact, there has been an upward movement, which has extended to a number of iron and steel materials. The rise in the price of scrap is one of the most notable features of the situation, and has had an influence on several products. For heavy steel scrap, suitable for making basic steel, a price has been paid which is 15s. per ton more than that of last summer. As the charge of a basic furnace is made up to at least half its extent of scrap, an advance of this kind adds considerably to the cost of producing basic steel, and higher prices for the finished product are therefore justified. The rise in the price of scrap has been brought about by a scarcity of the material. A revision has been made of the selling prices of Derbyshire and Lincolnshire foundry pig iron, and quotations for delivery now vary, I understand, according to the zone in which the buying works are situated. Derbyshire No. 3 foundry, delivered to the Sheffield district, is now quoted at 67s. 6d., which represents a further advance. The rates for finished iron, steel bars, coal, coke and also the charges for rolling, are all higher than they were last year. There is much scarcity of coke, and as a result some blast-furnaces have had to be damped down and the restarting of others has been interfered with. The price movement extends to some of the essential ingredients used in the manufacture of various alloy and high-speed steels, including ferro-chrome and tungsten, in both of which there have been very substantial increases.

Another Naval Order.

Vickers-Armstrongs, Ltd., of Sheffield and Barrow-in-Furness, who recently booked an order from the Admiralty for two destroyers, has now received a further contract for the building of a flotilla leader.

Two Company Reports.

Two reports of local companies, engaged in heavy engineering and railway work, which were published last week, make only moderately cheerful reading, as in both cases, although a dividend is declared, profits show a decline. Hadfields, Ltd., one of the largest Sheffield concerns, report a profit of £112,053, as compared with £187,223 in 1927, and the ordinary dividend is 2¼ per cent. as against 5 per cent. The directors state that "the demand for the company's products which was noted in 1927 and the earlier part of 1928 was not maintained during the latter part of the year, and with a general slackening of trade and increase of competition it has not been possible to maintain the high level reached in 1927. It is hoped, however, that the recent revival in the coal trade will before long be reflected in the company's activities." John Baker and Co., Ltd., of Rotherham, state that the year has been one of depression in the coal and iron industries and of low requirements from the home railways. As a consequence, there has been a poor demand for the company's products. In the early part of the year the plant was fairly well employed, but during the latter months it was working at a very low output. Since then there has been some improvement, but the work available is still very restricted. The surplus for the year is £18,458, as compared with £31,919 in 1927. The dividend is maintained at 5 per cent.

Cutlery and Plate.

The cutlery and plate trades show little or no sign of improvement, and the present aggregate turnover is probably below that of the corresponding period of last year. Good order books are reported in some cases, but these instances are exceptional. While there is a large output of stainless cutlery, spoons and forks, it is not equal to the average of recent years. The new non-inflammable substance for hafting table knives is being given a thorough trial, and a considerable quantity of knives in which it is used is being sent out. The chairman of Mappin and Webb, Ltd., at the annual meeting last week, stated that the Sheffield works of the company had been well occupied during the year, and they still had important contracts in hand. The Cutlers' Company is pursuing its campaign for protecting the trade name of Sheffield by taking proceedings in cases where goods bearing misleading marks are sold. At Lowestoft last week it prosecuted a firm for selling two carving knives with the words "Best English cutlery, Sheffield," inscribed on them, when they were really of inferior quality. Counsel for the prosecution said that the knives were made of low-class steel, and had been only roughly through two processes, whereas they ought to go through four. Once the cutting surface had gone, it could not be reground. The defendants pleaded "Guilty" to two summonses for selling. It was stated on their behalf that the knives were the sole survivors of an old stock that had been withdrawn after a previous case, and that the manager of the shop did not know they were on sale or available. The defendants were ordered to pay fines and costs totalling £50.

Rationalisation.

Sir Mark Webster Jenkinson, who is financial director of Vickers Ltd., a company which has taken a leading part in the rationalisation of the steel industry, suggested, at a dinner in Sheffield last week, that the same process should now be applied to the lighter trades of Sheffield. He said that in many cases business was carried on in old works with bad lay-outs and inefficient plant, and in such small units that economic production was practically impossible. He believed that in the cutlery trade there were 200 manufacturers; there were 70 table-knife manufacturers, 100 electro-plate manufacturers, and over 150 steel manufacturers. Many of them were manufacturing the same kind of product to the same pattern in small quantities, and many had not the capital necessary to put down labour-saving plant, which would enable them to cut their production costs by half and perhaps more, and even if they put down the plant they had not the turnover to justify the expenditure required. If they could sink some of their personal prejudices and bring in some sort of rationalisation for these lighter trades, they would get back again to their old position.

NORTH OF ENGLAND.

(From our own Correspondent.)

Naval and Mercantile Contracts.

THE placing of the remaining orders for destroyers by the Admiralty was awaited rather anxiously by Tyne-side builders, although there had been a feeling of quiet confidence that some of the orders would be secured. The fact that orders for four destroyers have been placed has given great satisfaction. Two are to be built by Palmers Shipbuilding and Iron Company, Ltd., Jarrow, and the others by Swan, Hunter, and Wigham Richardson, Ltd. A contract for the machinery for the last two destroyers has been placed with the Wallsend Slipway and Engineering Company, Ltd. On this occasion the Tyne has secured a distinct triumph over the Clyde. Prior to the war, the Tyne was never without naval contracts, and the new orders ensure a return to conditions which prevailed in other years. The vessels just placed are not required immediately, and their construction will not be accelerated. At present Hawthorn, Leslie and Co., Ltd., Hebburn, are building the two destroyers ordered in February of last year, and they have on hand also the two of this year's programme which they were officially announced to have received three weeks ago. Last week the firm passed into commission H.M.S. "Bridgewater," an improved type of mine-sweeper, for service in Eastern waters, and H.M.S. "Sussex," and another mine-sweeper, H.M.S. "Sandwich," has just undergone her acceptance trials. Swan, Hunter and Wigham Richardson, Ltd., secured the order for a flotilla leader last year, and a few weeks ago they were the successful contractors for two sloops, which are to be engined by Hawthorn, Leslie and Co. The two destroyers just announced will not only increase the considerable amount of work the Wallsend firm has in hand, but will also add to the variety, in which respect probably no company in Great Britain is so well situated. The Palmer Company is at present completing the cruiser H.M.S. "York." That company has also been successful in securing a contract for an ore-carrying vessel of 12,000 tons deadweight for the Rederi Odfjell, of Bergen. The vessel is to be delivered in March, 1930. The firm, it is understood, will also supply the engines. The ship is of the shelter deck type. It is not yet known whether it will be built at Jarrow or Hebburn, but it represents a considerable amount of employment, which is very welcome at the present time.

Cleveland Iron Trade.

The continued stringency in the supply of Cleveland pig iron is causing anxiety, and in some cases makers are heavily in arrears. Consumers are hoping for enlargement of output, though they realise that difficulty in obtaining coke may delay the promised re-kindling of idle blast-furnaces. Merchants have fairly substantial parcels of Cleveland iron to offer, but are precluded from selling in large quantities to North-East Coast consumers. They are, however, understood to have put through business with home firms elsewhere, and with buyers abroad. Makers have little or no iron to sell for delivery before May. Their fixed minimum prices still stand:—No. 1 foundry, 69s. 6d.; No. 3 G.M.B., 67s.; No. 4 foundry, 66s.; No. 4 forge, 65s. 6d.; and possibly these figures would still be accepted up to the end of the half-year, but for supply over periods beyond June 1s. 6d. per ton above the foregoing quotations is named.

East Coast Hematite.

Values of East Coast hematite pig iron are stated to have reached economic level, and show further upward tendency. In this branch also merchants are fairly well bought. Sellers have an entirely free hand as to prices they may charge, but terms of sale do not vary a great deal. Consumers experience difficulty in placing orders at below the equivalent of 74s. for ordinary qualities, and that may be given as the basis of market values.

Ironmaking Materials.

Iron and steel manufacturers who have not made provision for fuel and foreign ore supplies over the next few months are likely to be awkwardly placed soon, as shortage of these raw materials threatens to become more acute. Ore merchants are taking a firmer attitude than ever. They are not keen to make further sales, and quotations are ruled by best Rubio at fully 23s. c.i.f. Tees. Durham blast-furnace coke is heavily sold for export,

and producers are unable to meet the wishes of local consumers to make contracts well ahead. Good medium qualities are put at 19s. 6d. delivered to works in this area, and spot lots are reported to have realised 20s.

Manufactured Iron and Steel.

Aggregate output of manufactured iron and steel is heavier than for many years past, and promises to be larger, as producers of most descriptions are well sold, and new negotiations are resulting in business on a good scale. Foreign competition having been completely eliminated, semi-finished steel makers have probably more work on hand than ever before, while makers of several kinds of finished steel are exceptionally busy. Prices are firm, but unchanged. There is a marked scarcity of heavy steel scrap, and offers of 63s. 6d. per ton as the delivered price only attract small quantities. Ordinary heavy cast iron is steady at 62s. 5d., and machinery quality in handy sizes at 66s., but steel turnings have advanced to 54s. 6d., and cast iron borings are strong at 50s., all delivered works.

The Coal Trade.

The strong position in the Northern coal trade is still maintained. Continental advices report that German and Polish competition is again becoming keen, especially for late April and later shipment dates, and during the past few days considerable tonnage has been taken up to convey these competition coals to numerous centres, particularly to Swedish and Italian destinations. This move is consequently retarding to some extent the forward market for Northumberland and Durham coals. The continentals sound the local market keenly, but forward business is not coming definitely on the market, and there is indication of consumers holding off for May and onward shipments. Transactions this week have been chiefly confined to small spot cargoes, and for any such lots prices have been quoted at high figures. For all next month the position shows quite a firm tone. There is an abundant inquiry. Buyers, however, press for definite April deliveries, and offer the current quoted values, and every description of coal can be cleared at fully recent prices. The more forward outlook, however, shows that under competition from other centres, the overseas consumers anticipate much easier markets for May and onwards. Therefore, apparently they are confining their operations to definite April loading positions, and prices under the circumstances are quoted unchanged. There is no change in the coke trade position. Makers are well sold, and quote firm values. For next month the inquiry is slow, and buyers are not pressing on the market.

SCOTLAND.

(From our own Correspondent.)

Conditions Unchanged.

THE position in the steel, iron and coal trades shows practically no change since last week. There has been some talk of higher prices for steel, owing to increased costs of raw materials, but no definite action has yet been taken. There has been a slight downward movement in some descriptions of coal, but on the whole the market is unchanged with supplies showing very little improvement.

Steel.

The majority of the steel works are producing fair tonnages, and makers are not altogether without hope that the recent improvement in some branches will continue during the coming months. Heavy steel has become a shade quieter, but producers are confident that specifications will come to hand more frequently in the near future. Up to the present the seasonal demand for steel sheets has been somewhat disappointing. Sheet makers, too, are finding some difficulty in securing an increase in price sufficient to recompense them for the higher costs of raw materials imported from the Continent. Business in light sheets is better than the demand for heavy grades, and while galvanised descriptions are meeting with a fairly regular turnover, orders as a rule are comparatively small. Tube makers are doing a brisk business in all but lap-welded sorts, and these show signs of improvement Butt-welded hot-rolled, and solid-drawn tubes are all in active demand.

Iron.

The demand for pig iron has improved somewhat, and with stocks at a low ebb, some furnaces are being relit in order to satisfy customers' requirements. New business in bar iron is rather scarce, but accumulations during the recent stoppage still provide a fair amount of employment. The re-rolled steel departments are not quite so busy. Specifications are less prolific and the prices obtained hardly compensate for the advance in costs.

Scrap.

Supplies of scrap continue on a rather meagre basis, and prices are very firm at 72s. 6d. for heavy steel and 67s. 6d. heavy basic.

Manufactured Copper Advanced.

Manufactured copper was subject to three advances in price during the past week, amounting in all to £13 per ton, making the current price of strong £133 per ton basis.

Exports and Imports.

During the past week imports at Glasgow harbour included 17,000 tons of iron ore, 2400 tons of steel and iron from the Continent, and 1000 tons of pig iron. Shipments of steel and iron amounted to 1400 tons.

Coal.

The export department of the coal trade is quiet, and with home demands showing signs of weakening, it seems likely that the severe scarcity of fuel will soon be relieved to a considerable extent. West of Scotland collieries, as a rule, are well booked over the next two or three weeks, but, generally speaking, there is a distinct scarcity of business for April loading, and in the Lothians and Fifeshire districts the collieries are inclined to shade their prices in order to induce business. Exporters, however, are not inclined to commit themselves meanwhile, in anticipation of an appreciable drop in prices. The Swedish State Railways require offers by April 6th for 90,000 tons of Scottish, Northumberland, and Durham or Yorkshire steams for April-July shipment.

WALES AND ADJOINING COUNTIES.

(From our own Correspondent.)

Coal Trade Conditions.

THE loading position at South Wales docks is an extremely difficult one, the pressure all round being very heavy, and there is no doubt that many steamers will be held up right over the holidays, owing to the fact that shippers cannot get the coals they require, while others are prevented from even making a start with the loading as they cannot get a berth. At the end of last week there were thirty-five steamers waiting to load, and on Monday this number was increased to thirty-nine. The amount of demurrage which has been incurred during the last few weeks by shippers has been very heavy. Quite a number of steamers have become liable to demurrage before they have even begun to load their cargoes. It is difficult to explain why this should be the case, unless it is that collieries have been sadly disappointed in their outputs, and production has fallen far short of what was expected in view of the reopening of pits and the employment of additional men at others. Shipments last week showed a slight improvement upon those of the previous week, and were well over the half a million tons mark. Holidays will, of course, interfere with results during the current week and next, but a good market is looked for throughout the whole of April, and, in fact, right up to the end of May. Quite apart from the general inquiry from abroad, there is the fact that numerous orders which should have been executed this month have had to be put off until April, owing to the shortage of coals, while it is very well known that the majority of the coaling depôts abroad are far from being well stocked, which means that further demands will be forthcoming on this account during the next few weeks. Reports show that most of the leading colliery undertakings are already very fully booked up for the whole of next month, and are asking 22s. to 22s. 6d. for superior large coals and 15s. to 15s. 6d. for best small coals for any supplies that they may have for delivery during the next few weeks. One or two contracts have recently been entered into for coals and patent fuel over a period of about three to six months, while the Egyptian State Railways have issued tender forms in respect of their requirements from June to August, the quantity which firms are asked to tender for being 180,000 tons c.i.f. Alexandria.

Regulation Schemes.

From all accounts, efforts to co-ordinate the various district schemes for the regulation of coal production and prices have so far failed, and discussions on these lines have been dropped for the time being, the idea now being to concentrate more on a national scheme, whereby the elimination of competition between the different districts might be achieved. There is no doubt that the task of co-ordinating the existing schemes is a prodigious one, and, in fact, almost impossible, for they are all on different lines. So far as South Wales is concerned, it is more correct to say that there is no scheme in existence at all for the reason that the regulation of coal prices has all along been on a voluntary basis. The Coal Marketing Association which was formed last year never got as far as legal sanction, because it lacked sufficient support, and the agreement framed remained operative only up to the end of 1928, since when it has not been renewed. At the end of last year the coalowners contemplated a wider scheme, embracing not only the regulation of prices, but production as well; but this scheme also failed to secure the support which was felt necessary for it successfully to achieve the object in view, and it was never adopted. Since then, of course, the coal export trade has taken on quite a different complexion from that which was experienced during the depression of last year, rendering temporarily, at any rate, the adoption of any such scheme unnecessary. In fact, the whole scheme has fallen quite into the background, but there are many who consider that now is the time to give calm consideration to the whole problem and frame a scheme that can be adopted without delay, if and when the conditions need it. At any rate, the view is held that the minimum prices which were originally fixed should now be revised and put at a level which will avoid collieries making the losses which they formerly incurred.

Holidays at the Docks.

Reference was made last week to the fact that the official holidays in the coalfield will be Monday and Tuesday next week. It has now been arranged that so far as the docks are concerned, work will continue on Thursday of this week from 7 a.m. to 10 p.m. There will be no work on Good Friday. On Saturday work will be as usual, with none on Easter Monday, but on Tuesday work will commence at 7 a.m. and finish at twelve noon, while on Wednesday there will be the usual working from 7 a.m.

Current Business.

To all intents and purposes business has been at a standstill all this week, for the reason that collieries have no coals to spare for shipment before the holidays, or, indeed, for the first fortnight in April. They have such heavy commitments in respect of tonnage in dock that most of them are unable to cope with the situation. In the circumstances, prices are practically nominal and most colliery salesmen are not disposed to quote for April until they can see their position more clearly. The market is firm all round for all descriptions of coal, pit-wood being steady at 27s. to 27s. 3d.

LAUNCHES AND TRIAL TRIPS.

STANALSFALT, single-screw steamer; built by Palmer's Shipbuilding and Iron Company, Ltd., to the order of the Standard Shipping Company; to carry 2100 tons asphalt in bulk. Engines, triple-expansion; constructed by the builders; launch, March 12th.

BHUTAN, single-screw steamship; built by Harland and Wolff, Ltd., Govan; to the order of Hain Steamship Company, Ltd.; dimensions, 452ft. 6in. by 57ft. 4in. by 40ft. 9in.; to carry cargo. Engines, quadruple-expansion, 30½in., 44in., 63½in. and 91in. diameter by 60in. stroke, pressure 230 lb. per square inch; constructed by the builders; trial trip, recently.

COTEAUDOC, single deck screw steamer; built by Barclay, Curle and Co., Ltd.; to the order of Paterson Steamships, Ltd., Canada; dimensions, 259ft. by 43ft. 2in. by 20ft.; to carry about 2585 tons. Engines, triple-expansion, pressure 180 lb. per square inch; constructed by the builders; launch, March 14th.

MAYA, single-screw steamer; built by Barclay, Curle and Co., Ltd.; to the order of the Cuyamel Fruit Company, of New Orleans; dimensions, 405ft. 5in. by 53ft. by 33ft. 6in.; to carry passengers and bananas. Engines, four-cylinder triple-expansion, 30½in., 51in., 62in. and 62in. diameter by 48in. stroke, pressure 200 lb. per square inch; constructed by the builders; launch, March 14th.

EDUCATIONAL INTELLIGENCE.

THE Board of Education will offer in 1930 twenty Royal Scholarships and eleven Free Studentships tenable at the Imperial College of Science and Technology, London. These awards are open to British subjects of either sex and there is at present no age limit. A Royal Scholarship or a Free Studentship entitles the holder to payment by the Board of the fees for admission to the lectures and laboratory and other work appropriate to the course followed by the holder and approved by the Board. A Royal Scholarship will also include such maintenance allowance, at a rate not exceeding £80 a year, as the Board think fit, having regard to the other financial resources of the scholar. The awards will be made on the results of the Science Scholarships Examination which will be held by the Board at various centres beginning Wednesday, April 30th, 1930. Applications for entry to the examination must be made on the prescribed form, obtainable from the Board, not later than January 15th, 1930.

WHITWORTH SCHOLARSHIPS.—The following scholarships and prizes on the foundation of Sir Joseph Whitworth are offered for competition in 1930 to candidates possessing handicraft experience obtained in a mechanical engineering workshop:—(*a*) Two Whitworth Senior Scholarships of an annual value of £250, tenable for two years; (*b*) six Whitworth Scholarships of an annual value of £125, which may be increased in special cases if the Board think fit, tenable for three years; (*c*) Whitworth Prizes not exceeding twenty-five in number of the value of £10 to unsuccessful competitors for Whitworth Scholarships whose work appears to deserve recognition. The awards will be made on the results of an examination held by the Board in May, 1930. Applications for admission to the competition in 1930 must be made on the prescribed form, obtainable from the Board, not later than January 15th, 1930.

PERSONAL AND BUSINESS ANNOUNCEMENTS.

STANTON AND CO. (Frank Stanton), of Charterhouse Chambers, Charterhouse-square, London, E.C. 1, ask us to announce that they are now acting as sales representatives to Vickers-Armstrongs, Ltd., for the non-ferrous products made at the Elswick Works, Newcastle-upon-Tyne, for London and South-Eastern Counties.

CONTRACTS.

SIR W. G. ARMSTRONG, WHITWORTH AND CO., Ltd., desire us to say, with reference to the order secured from the Central Argentine Railway for twenty heavy 4–8–4 type locomotives, that they will not be shipped in running order—as stated in some places—but in parts for erection in South America.

THE CENTRAL ELECTRICITY BOARD has placed orders amounting to approximately £1,500,000 for work in connection with the South-East England scheme, the Central England scheme, and the North-West England scheme as follows:—South-East England scheme: for 66-kV and other transformers in the London area, with Hackbridge Electric Construction Company, Ltd., Hackbridge, Surrey; and the British Electric Transformer Company, Ltd., Hayes, Middlesex. Central England: for 132-kV transformers, with the British Thomson-Houston Company, Ltd., Kingsway, London; and the British Electric Transformer Company, Ltd., Hayes, Middlesex. North-West England: (1) for 132-kV transformers, with the British Electric Transformer Company, Ltd., Hayes, Middlesex; the British Thomson-Houston Company, Ltd., Kingsway, London; and Ferranti, Ltd., Hollinwood, Lancs; (2) for 132-kV outdoor switchgear, with Ferguson, Pailin, Ltd., Strand, London; and the Metropolitan-Vickers Electrical Company, Ltd., Westminster, London.

INSTITUTION OF MECHANICAL ENGINEERS: GRADUATES' SECTION.—The annual dinner of the Graduates' Section of the Institution of Mechanical Engineers was held at Rumpelmayer's Restaurant on Friday, March 22nd, with Mr. Harold Heywood, chairman, in the chair, and the President of the Institution as principal guest. The evening passed very pleasantly. The speeches were commendably short and amusing, and there was an excellent musical programme provided partly by the talent of members and partly by professionals. The attendance was the biggest up to date, but one could not fail to notice that there were very few members from the provinces, which, since the establishment of Local Branches, hold their own dinners. It was observed by the Chairman that more than one-third of the company was composed of "Central" men, and the other Colleges were urged to do better. The toasts of the evening were proposed by Mr. Reginald Wailes, Hon. Secretary of the Section, by Mr. H. Steward, and by Mr. Pendred, and the responses were made by Mr. Adamson (President), Wing Commander T. R. Cave-Brown-Cave, and Mr. Heywood. The graduates are to be congratulated upon the arrangements and the swing with which the evening was carried through.

Current Prices for Metals and Fuels.

IRON ORE.

N.W. Coast—	
(1) Native	18/6 to 19/-
(1) Spanish	21/-
(1) N. African	21/-
N.E. Coast—	
Native	18/- to 21/-
Foreign (c.i.f.)	23/-

PIG IRON.

	Home. £ s. d.	Export. £ s. d.
(2) Scotland—		
Hematite	3 15 0	—
No. 1 Foundry	3 15 0	—
No. 3 Foundry	3 12 6	—
N.E. Coast—		
Hematite Mixed Nos.	3 14 0	3 14 0
No. 1	3 14 6	3 14 6
Cleveland—		
No. 1	3 9 6	3 9 6
Silicious Iron	3 9 6	3 9 6
No. 3 G.M.B.	3 7 0	3 7 0
No. 4 Foundry	3 6 0	3 6 0
No. 4 Forge	3 5 6	3 5 6
Mottled	3 5 0	3 5 0
White	3 5 0	3 5 0
Midlands—		
(3) Staffs.—	(*Delivered to Station*)	
All-mine (Cold Blast)	—	—
North Staffs. Forge	3 11 0	—
„ „ Foundry	3 15 0	—
(3) Northampton—		
Foundry No. 3	3 9 0	—
Forge	3 5 0	—
(1) Derbyshire—		
No. 3 Foundry	3 12 6	—
Forge	3 8 6	—
(3) Lincolnshire—		
No. 3 Foundry	3 5 0	—
No. 4 Forge	3 0 0	—
Basic	3 2 6	—
(4) N.W. Coast—		
N. Lancs. and Cum.—		
Hematite Mixed Nos.	4 2 6 (*a*) / 4 6 0 (*b*) / 4 9 0 (*c*)	—

MANUFACTURED IRON.

	Home. £ s. d.	Export. £ s. d.
Scotland—		
Crown Bars	10 5 0	9 15 0
Best	—	—
N.E. Coast—		
Iron Rivets	11 10 0	—
Common Bars	10 5 0	—
Best Bars	10 15 0	—
Double Best Bars	11 5 0	—
Treble Best Bars	11 15 0	—
Lancs.—		
Crown Bars	10 10 0	—
Second Quality Bars	10 0 0	—
Hoops	13 0 0	—
S. Yorks.—		
Crown Bars	10 10 0	—
Best Bars	11 10 0	—
Hoops	12 10 0	—
Midlands—		
Crown Bars	9 7 6 to 10 0 0	—
Marked Bars (Staffs.)	12 0 0	—
Nut and Bolt Bars	8 12 6 to 8 17 6	—
Gas Tube Strip	10 15 0	—

STEEL. (*d*)

	(6) Home. £ s. d.	(7) Export. £ s. d.
(5) Scotland—		
Boiler Plates	10 10 0	10 10 0
Ship Plates, ½in. and up	8 7 6	7 12 6
Sections	7 17 6	7 2 6
Steel Sheets, ¼in.	8 15 0	8 12 6
Sheets (Gal. Cor. 24 B.G.)	13 10 0	13 12 6 to 13 15 0

STEEL (*continued*).

	Home. £ s. d.	Export. £ s. d.
N.E. Coast—		
Ship Plates	8 7 6	—
Angles	7 17 6	—
Boiler Plates	12 15 0	—
Joists	7 17 6	—
Heavy Rails	8 10 0	—
Fish-plates	12 0 0	—
Channels	10 5 0	£9 to £9 5
Hard Billets	7 15 0	—
Soft Billets	6 15 0	—
N.W. Coast—		
Barrow—		
Heavy Rails	8 0 0	—
Light Rails	8 5 0 to 8 10 0	—
Billets	6 15 0 to 9 10 0	—
Manchester—		
Bars (Round)	8 17 6	—
„ (Small Round)	8 10 0 to 8 15 0	—
Hoops (Baling)	10 0 0	9 15 0
„ (Soft Steel)	9 0 0	8 15 0
Plates	8 12 6 to 8 17 6	—
„ (Lancs. Boiler)	9 12 6 to 9 17 6	—
Sheffield—		
Siemens Acid Billets	8 15 0 to 9 0 0	—
Hard Basic	8 15 0	—
Intermediate Basic	7 5 0 to 7 15 0	—
Soft Basic	7 0 0	—
Hoops	9 10 0	—
Soft Wire Rods	7 12 6	—
Midlands—		
Small Rolled Bars	8 2 6 to 8 5 0	—
Billets and Sheet Bars	6 5 0 to 6 10 0	—
Sheets (20 W.G.)	11 10 0 to 12 0 0	—
Galv. Sheets, f.o.b. L'pool	13 7 6 to 13 10 0	—
Angles	7 17 6	—
Joists	7 17 6	—
Tees	8 17 6	—
Bridge and Tank Plates	8 12 6	—
Boiler Plates	9 15 0	—

NON-FERROUS METALS.

Swansea—	
Tin-plates, I.C., 20 by 14	18/3 to 18/6
Block Tin (cash)	220 0 0
„ „ (three months)	220 17 6
Copper (cash)	95 7 6
„ (three months)	96 15 0
Spanish Lead (cash)	26 7 6
„ „ (three months)	26 6 3
Spelter (cash)	27 10 0
„ (three months)	27 8 9
Manchester—	
Copper, Best Selected Ingots	109 10 0
„ Electrolytic	112 0 0
„ Strong Sheets	138 0 0
„ Tubes (Basis Price), lb.	0 1 6½
Brass Tubes (Basis Price), lb.	0 1 3½
„ Condenser, lb.	0 1 5½
Lead, English	28 10 0
„ Foreign	26 15 0
Spelter	27 15 0
Aluminium (per ton—raw ingot)	£95

FERRO ALLOYS.

	Per Ton.	Per Unit.
Tungsten Metal Powder	2/- per lb.	
Ferro Tungsten	1/10 per lb.	
Ferro Chrome, 4 p.c. to 6 p.c. carbon	£23 17 6	7/6
„ „ 6 p.c. to 8 p.c.	£22 to £23	7/-
„ „ 8 p.c. to 10 p.c.	£22 0 0	6/-
„ „ Specially refined		
„ „ Max. 2 p.c. carbon	£38 0 0	12/-
„ „ „ 1 p.c. carbon	£40 0 0	15/-
„ „ „ 0·70 p.c. carbon	£45 0 0	17/-
„ „ „ carbon free	1/- per lb.	
Metallic Chromium	2/7 per lb.	
Ferro Manganese (per ton)	£13 15 0 for home; £13 10 0 for export	
„ Silicon, 45 p.c. to 50 p.c.	£12 0 0 scale 5/- per unit	
„ „ 75 p.c.	£19 0 0 scale 6/- per unit	
„ Vanadium	13/9 per lb.	
„ Molybdenum	3/8 per lb.	
„ Titanium (carbon free)	1/- per lb.	
Nickel (per ton)	£170 to £175	
Ferro-Cobalt	9/6 per lb.	

FUELS.

SCOTLAND.

(*Prices not stable.*)

	Export.
Lanarkshire—	
(f.o.b. Glasgow)—Steam	17/-
„ „ Ell	18/6
„ „ Splint	19/- to 19/6
„ „ Trebles	16/6
„ „ Doubles	16/-
„ „ Singles	14/-
Ayrshire—	
(f.o.b. Ports)—Steam	16/-
„ „ Jewel	17/6
„ „ Trebles	16/-
Fifeshire—	
f.o.b. Methil or Burntisland—Steam	15/6 to 17/-
Screened Navigation	19/6
Trebles	16/6
Doubles	15/6 to 16/-
Singles	14/-
Lothians—	
(f.o.b. Leith)—Best Steam	16/-
Secondary Steam	15/6
Trebles	16/-
Doubles	15/6 to 15/9
Singles	13/6

ENGLAND.

	Export.
(8) N.W. Coast—	
Steams	23/-
Household	39/6 to 52/-
Coke	23/6 to 24/-
Northumberland—	
Best Steams	16/6 to 17/-
Second Steams	15/6 to 16/-
Steam Smalls	10/6 to 11/-
Unscreened	14/- to 14/6
Household	21/- to 27/-
Durham—	
Best Gas	15/6
Second	15/-
Household	21/- to 27/-
Foundry Coke	22/6 to 25/-
Sheffield—	Inland.
Best Hand-picked Branch	27/- to 28/6 —
Derbyshire Best Bright House	23/6 to 25/- —
Best House Coal	21/- to 22/- —
Screened House Coal	18/- to 19/- —
„ „ Nuts	17/- to 19/- —
Yorkshire Hards	15/6 to 16/6 —
Derbyshire Hards	15/6 to 16/6 —
Rough Slacks	8/6 to 9/6 —
Nutty Slacks	6/- to 7/- —
Smalls	3/6 to 4/- —
Blast-furnace Coke (Inland)	14/6 at ovens —
Furnace and Foundry Coke (Export), f.o.b.	20/6 to 22/6

(9) SOUTH WALES.

Cardiff—	
Steam Coals :	
Best Smokeless Large	21/6 to 22/-
Second Smokeless Large	21/- to 21/3
Best Dry Large	21/- to 21/6
Ordinary Dry Large	20/- to 21/-
Best Black Vein Large	20/6 to 21/-
Western Valley Large	20/3 to 20/6
Best Eastern Valley Large	19/6 to 20/-
Ordinary Eastern Valley Large	19/- to 19/6
Best Steam Smalls	14/9 to 15/6
Ordinary Smalls	13/- to 14/6
Washed Nuts	20/- to 25/-
No. 3 Rhondda Large	21/- to 22/-
„ „ Smalls	15/- to 16/-
No. 2 „ Large	18/6 to 19/-
„ „ Through	17/- to 18/-
„ „ Smalls	13/6 to 14/-
Foundry Coke (export)	27/- to 37/-
Furnace Coke (export)	19/- to 21/-
Patent Fuel	20/6 to 21/6
Pitwood (ex ship)	27/- to 27/3
Swansea—	
Anthracite Coals :	
Best Big Vein Large	33/- to 35/-
Seconds	25/- to 29/-
Red Vein	24/- to 27/-
Machine-made Cobbles	40/- to 43/6
Nuts	40/- to 44/-
Beans	23/6 to 25/6
Peas	16/6 to 17/6
Breaker Duff	9/6 to 10/-
Rubbly Culm	11/- to 11/6
Steam Coals :	
Large	18/- to 19/-
Seconds	17/- to 18/-
Smalls	11/- to 13/-
Cargo Through	15/9 to 16/9

(1) Delivered. (2) Net Makers' Works. (3) f.o.t. Makers' Works, approximate. (4) Delivered Sheffield. (5) Glasgow, Lanarkshire and Ayrshire.

(6) Home Prices—All delivered Glasgow Station. Boiler Plates 10/- extra delivered England. (7) Export Prices—f.o.b. Glasgow. (8) Except where otherwise indicated. coals are per ton at pit for inland and f.o.b. for export, and coke is per ton on rail at ovens and f.o.b. for export. (9) Per ton f.o.b. (*a*) Delivered Glasgow. (*b*) Delivered Sheffield.

(*c*) Delivered Birmingham. (*d*) Rebate 12/6 joists and 10/- all other materials if home consumers confine purchases solely to British products.

French Engineering Notes.

(*From our Correspondent in Paris.*)

Rail Union.

THE fate of the European Rail Makers' Association remained in the balance until the last moment of the long and arduous discussion in Brussels, when continental makers practically conceded the British claims in return for certain concessions. Had the Rail Union come to grief, it is believed that it would have affected seriously the situation of the Steel Cartel, for the operations of this latter body are becoming more difficult in view of the narrowing margin between continental and British costs, and it is still hoped that British steel makers will eventually come into line with continental producers. Of even more importance is the possibility of reaching United States rail makers through the British. At present the British quota of rails includes the amount accorded to the Americans, who were not allowed by their legislation to become a party to any trust, but as they appear now to enjoy more liberty in this respect, it is hoped that they will become direct members of the European Rail Makers' Association. Under these circumstances, the continental rail makers gave in to the British over most of the points under discussion. The Dominions and Crown Colonies are regarded as British markets, and South American and other railway companies will continue to specify British rails if they please. On the other hand, the British were unable to obtain a larger quota, but, in compensation, the total tonnage excluded from the penalty clause has been raised, while the penalties themselves have been increased proportionately in excess of the amounts allotted.

Import Duty on Electricity.

A considerable quantity of electrical energy is transmitted into the eastern departments of France from Switzerland, but it was never suggested that current was liable to payment of import duty until the Customs Department brought an action a year ago against the Compagnie Lorraine d'Electricité, of Nancy, for failing to make a declaration of the quantity of electricity transmitted during the previous three years. In the lower courts judgment was given in favour of the Compagnie Lorraine, on the ground that as electricity was not a measurable substance—that is to say, it was not a material product that could be measured when passing the frontier —there was nothing in the tariff legislation that entitled the Customs Department to claim an import duty upon it. The Customs carried the matter to the Cours de Cassation, which reversed the previous judgments, and declared that electrical energy should be regarded as ordinary merchandise, and therefore liable to payment of duty. The fines imposed upon the Compagnie Lorraine and the costs amount to close upon 100 million francs. This judgment settles a point that has been exercising the minds of the authorities ever since the programme for laying down vast hydro-electric power plants was started upon. Switzerland has done a good business in supplying the surplus to French users across the border, and now that the Kembs power station is to be constructed, and seven others are expected to be laid down as the Alsace Canal is proceeded with, it is felt that some protection should be secured against the importation of cheap energy from that country.

Steel Coaches.

Following upon recent references to steel railway coaches, it is explained that the order for 200 all-metal postal vans which was sanctioned last year has been held up pending an official inquiry into the behaviour of some steel coaches recently in service. There is a hasty assumption in some quarters abroad that all the steel coaches delivered have proved defective, whereas the trouble appears to have arisen with one type of coach. It is not suggested that the same defects exist in all the metal coaches in service, but the Government has ordered a complete inquiry into the troubles complained of before placing orders independently of those that are given out by the railway companies themselves.

Railway Progress.

In its annual report the Paris and Orleans Railway Company deals with improvements that were carried out during the past year, with regard to increasing steam locomotive efficiency by the use of feed-water heaters, and with the experiments that have been made with higher steam pressures and the use of poppet valves. Very shortly more than 1000 locomotives will be equipped with repetition signal apparatus in the cabs. On electric locomotives a great deal of experimental work has been done with a view to solving the problems of starting, speed variation and electrical braking by recuperation. The consumption of energy during the year was 123 million kilowatt-hours. The Eguzon hydro-electric power station supplied the company with 76 million kilowatt-hours out of a total of 103 million kilowatt-hours. About 60 per cent. of the energy absorbed by the Paris–Orleans Company comes from hydraulic sources.

Foreign Capital.

If it were not for the legislation which requires a French controlling interest in companies other than those formed under the new limited liability laws, the situation arising out of the invasion of foreign capital would be more serious than it is, although it is regarded as quite serious enough. Electrical engineering undertakings are, especially, the object of solicitude on the part of foreign financiers, who have, in some cases, acquired so great an interest in them as to lead to the belief that the French will lose some of their independence, and that the effect may be to favour foreign manufacturers of electrical machinery to the detriment of the French. The supposed danger arises not so much from Transatlantic financial influences, which are already predominant in the electrical engineering industry, as in the attempt of foreign capitalists to secure important holdings in the big hydro-electric and other producing companies through the medium of Swiss groups.

British Patent Specifications.

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

Copies of Specifications may be obtained at the Patent Office Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., at 1s. each.

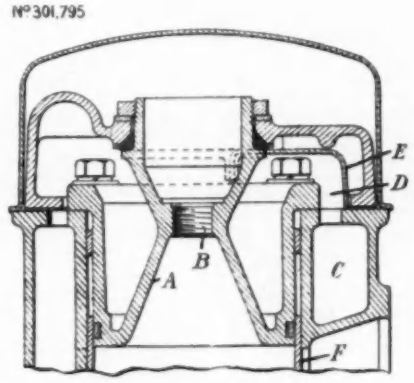
The date first given is the date of application; the second date, at the end of the abridgment, is the date of the acceptance of the complete Specification.

INTERNAL COMBUSTION ENGINES.

301,795. August 28th, 1928.—COOLING THE HEADS OF SLEEVE VALVE ENGINES, *British Continental Motors, Ltd.*, 150, *Saint Vincent-street, Glasgow.*

In this engine the cylinder head A forms a water jacket round the sparking plug opening B and communicates with the main

N° 301,795



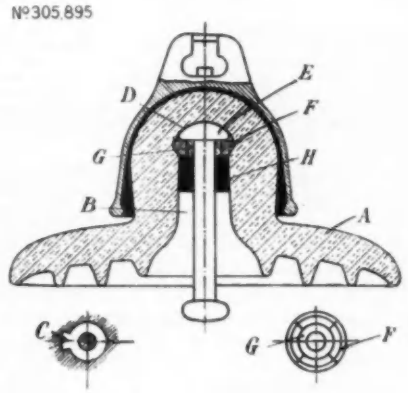
cylinder jacket C through the passage D. Water rising in the main jacket is deflected downwardly into the head jacket by the baffle E, which is arranged on one side only of the cylinder. The arrangement is said to improve the cooling of the sparking plug. The sleeve valve is shown at F.—*February 14th*, 1929.

TRANSMISSION OF POWER.

305,895. June 22nd, 1928.—ELECTRIC SUSPENSION INSULATORS, Max Hentschel and Franz Müller, both of Meuselwitz, Thuringia, Germany, trading as Porzellanfabrik Hentschel and Müller.

The insulator described in this specification comprises the usual insulating member A which, according to the invention, is formed with a smooth neck B, the channel C which is present in the known insulating member being omitted. The enlarged space D above the neck is lined with elastic material and forms

N° 305,895

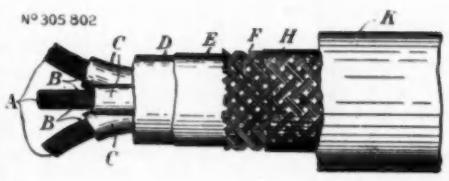


a shoulder through the medium of which the insulating member is adapted to interlock with a headed bolt E. The head of the latter is admitted through the neck, and retaining elements in the form of ring segments F are adapted to pass up the neck along the bolt into the space D. Subsequently a spreading element in the form of an integral or a divided sleeve G is passed up the bolt so as to spread the segments apart and lock the bolt to the insulating member. The elements may be secured in position by means of a lead seal H.—*February 14th*, 1929.

305,802. January 28th, 1928.—MANUFACTURE OF ELECTRIC CABLES, Wilfrid Stephen Taylor, of 9, Caithness-drive, Wallasey, Chester.

The cable illustrated is of the kind wherein the metallic conductors are in the form of a series of plaited or twisted strands of copper wire. During the manufacture the three inner conductors A are each passed through a tape wrapping machine which wraps

N° 305,802



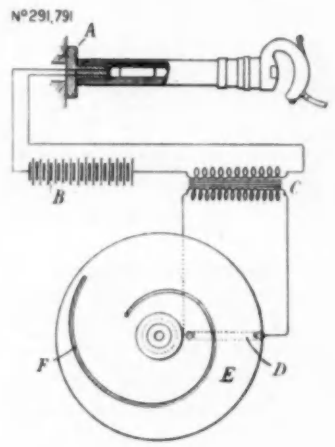
thereon, preferably in double layers, a tape or strip B of viscose, cellulose acetate or other suitable cellulose substances such as the nitro cellulose compounds. When the conductors A have been covered with the wrappings of viscose the rubber casings C are applied in the usual manner and the three conductors then embedded in the outer casing D of rubber. Subsequent to this operation the partially formed cable is passed through the tape wrapping machine and layers of viscose E are applied to the exterior of the casing D. The outer tubular plaited metallic conductor F is then laid over the viscose or the similar layers E, whereupon the partially formed cable is again passed through the wrapping machine and further layers H of viscose are applied to the exterior of the tubular plaited conductor F. The cable is covered finally with an outer rubber casing K which is applied in the known manner. Since the viscose or other cellulose substance employed as a covering for the metallic conductors is impervious to the action of sulphur, the vulcanisation of the rubber can be effected without any danger of chemical action taking place between the sulphur contained in the rubber and the copper conductors, thereby obviating the possibility of deterioration of the conductors by the formation of copper sulphides or other deleterious chemical compounds.—*February 14th*, 1929.

MEASURING AND TESTING INSTRUMENTS.

291,791. May 16th, 1928.—APPARATUS FOR MEASURING THE FREQUENCY OF RECIPROCATIONS OF A MOVING BODY, Tatsurni Takahashi, 35, Esahimachi, Higashi-Ku, Osaka, Japan.

This contrivance is put forward primarily as a means of recording the speed of operation of a pneumatic hammer. The tool is provided with a special plug fitting A, which is equipped with two electric leads. Every time the hammer strikes the plug a circuit is completed through a battery B and a transformer C. The secondary of the transformer supplies a spark discharge tube D. This tube is arranged beneath a rotary table E driven by a high-speed motor, such as a syren turbine. The disc is pierced by a scroll shaped slot F, and is equipped with a revolution counter. By relative disposition of the revolving aperture and the fixed spark discharge tube at the moment when the

N° 291,791



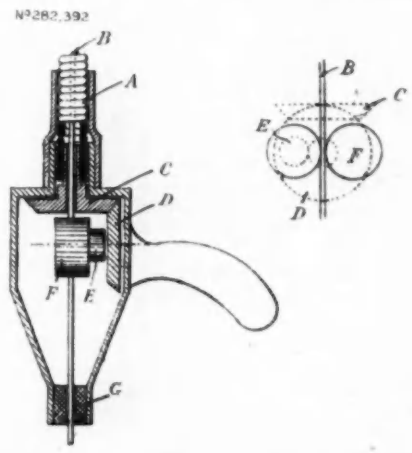
latter is flashed, a number of disconnected lights or luminous images sighted through the aperture will, owing to the persistence of vision, appear as to be moving to and fro in single file on the rotating disc along the luminous zone of the fired spark discharge tube, while the number of revolutions of the rotating disc is low, and when it reaches to a certain amount these luminous images change into only one image which appears to be travelling repeatedly in one direction, or in the other, or to stand still, according as the number of revolutions of the rotating disc is lower, higher, or equal to the frequency of the flashes. In this manner the frequency of the flashes or the illuminations, which is equal to the number of reciprocations of the moving body, can be measured by reading the speed of the rotating disc by means of a suitable tachometer, at the moment when only one uninterrupted luminous image stands still on the dial.—*February 14th*, 1929.

MACHINE TOOLS AND SHOP APPLIANCES.

282,392. December 13th, 1927.—ELECTRODE HOLDERS FOR ARC WELDING, Robert Sarazin, of 48, Boulevard d'Asnieres, Neuilly-sur-Seine (Seine), France.

This specification describes a hand arc welding electrode carrying rollers for feeding a flexible electrode to the work, the rollers being operated by a flexible driving shaft which is hollow and serves as a guide for the electrode. The rotation of the flexible shaft A is produced by a motor placed near the reel which contains the electrode wire B. The electrode wire B passes through the interior of the flexible transmission cover A.

N° 282,392

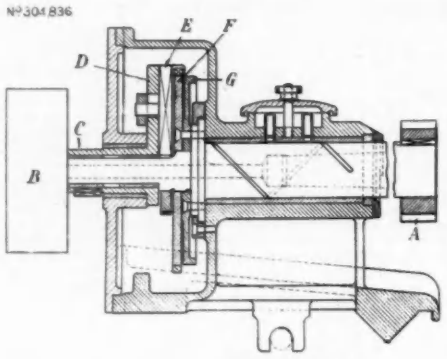


The flexible transmission may be covered by a copper sheath which will act as a conductor for leading in the current, and the whole arrangement may be protected by an insulating cover. The movement of rotation of the flexible member is transmitted by a small hollow shaft to the bevel pinions C which rotates the bevel pinion D. The shaft of the pinion C carries a small spur gear which drives a wheel E rigid with a set of driving or feed rollers F. The wire B is thus drawn between the rollers and pushed towards the member to be welded by passing through the nozzle G. The motor which produces the rotation of the

flexible member may have an automatic starting and stopping device controlled by the arc itself, and its speed may be a function of the characteristics of the arc in order to permit a varying speed of advance of the wire. The apparatus is completed by a grip which the operator holds in his hand in order to direct the welding.—*February 21st*, 1929.

304,836. June 19th, 1928.—GRINDING GEAR TEETH, C. D. P. Smallpiece, 3, Dalton-road, Coventry; and J. H. Rivers, Springfield, Northenden-road, Gatley, Cheshire.

This grinding machine is of the type in which the gear wheel A is acted upon by a bevelled grinding wheel while it is oscillated and is reciprocated in a direction parallel with the axis of the grinding wheel. At the same time the grinding wheel is travelled along the length of the gear teeth. The two linear movements are produced preferably, it is stated, by hydraulic means. The oscillatory movement is provided by a pair of steel bands

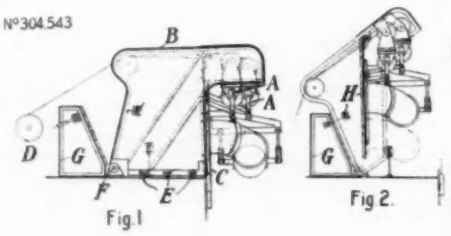


wrapped round the drum B and attached to brackets on the main frame of the machine. The longitudinal movement of the slide consequently rotates the drum. The drum is mounted on a sleeve C which carries a plate D. This plate is furnished with a pawl E which engages with a notched indexing disc F. The indexing from one tooth to another is effected by a trip gear operated by the grinding wheel slide. The work-holding spindle is provided with a brake drum G to hold it steady while indexing is taking place. The specification includes several other drawings.—*January 31st*, 1929.

SHIPS AND BOATS.

304,543. May 10th, 1928.—GEAR FOR HANDLING THE SUCTION PIPES OF DREDGERS, H. de Korte, E. 160, Moerdijk, Province of South Holland, Netherlands, and N. V. Gebroeders de Korte's Scheepswerf Moerdijks Welvaren, Moerdijk.

In this gear the suction bend of the dredger is supported at the point where it is connected to the pump suction by rope tackles A A carried by two jibs, one of which is shown at B. The

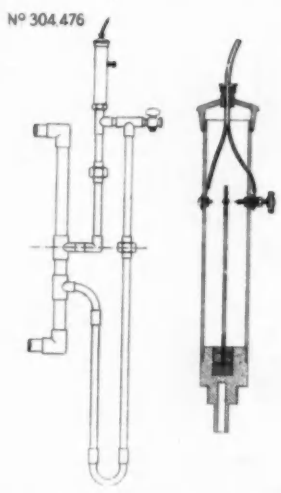


inboard end of the pipe has a large flange which engages with vertical slides C. When it is required to hoist the pipe inboard the winch D is used first to raise it up in the slides, and then, with the holding down bolts E slacked off, to tilt the jibs back, on the trunnion F, to rest against the support G. The guides at the same time rise up and come inboard to the position shown in Fig. 2. Clamps are provided to secure the gear in the inboard position.—*January 24th*, 1929.

MISCELLANEOUS.

304,476. January 24th, 1928.—LOW-WATER ALARMS FOR BOILERS, A. Butler and R. Butler, 7, Beechcroft-road, Bushey, Herts.

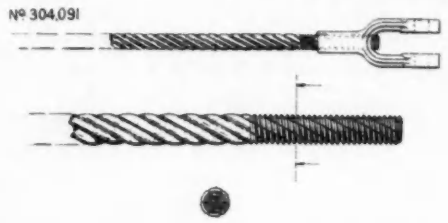
In this specification claim is made principally for the arrangement of the piping, which is said to give a sudden change of temperature for working a thermostatic alarm. The piping



system is described as follows:—"A low-water level alarm or indicator for steam generators, comprising a pipe or conduit having a water connection and a steam connection with the generator, a loop of piping or conduit in free communication with said pipe or conduit at the lowest permissible water level, and a thermostatic device connected to the said loop and controlling an electrically-operated audible or visual signal, the arrangement being such that when in use the loop is normally charged with water that is not subjected to convection currents and is therefore relatively cold, but upon the water level falling to a predetermined low level steam passes into the said loop with the result that the thermostatic device becomes heated and at once acts to close the alarm or indicating circuit." A simple form of bi-metallic thermostat is also illustrated.—*January 24th*, 1929.

304,091. May 5th, 1928.—FIXING CAPELS TO WIRE ROPES, *L. Mellersh-Jackson*, 28 *Southampton-buildings, Chancery-lane, London, W.C. 2.*

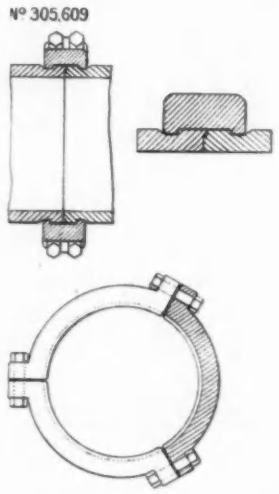
The inventors propose to fix wire ropes to their fittings by



screwing them in as shown. The screw is formed on the rope by a process of swaging.—*January 17th*, 1929.

305,609. November 7th, 1927.—PIPE JOINTS, Vickers, Ltd., Vickers House, Broadway, Westminster, and D. M. Anderson, River Don Works, Sheffield.

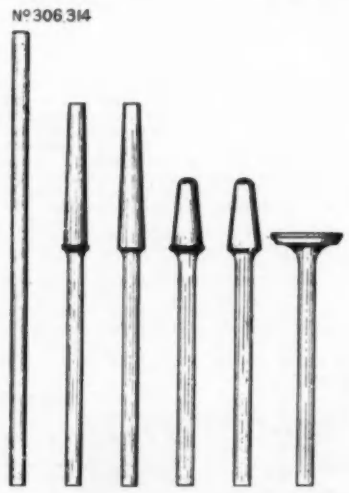
The joint shown in the illustrations of this specification is said to avoid the necessity for large and heavy flanges on the several lengths of piping, and to provide a fluid-tight joint. The joint is effected at the abutting ends of the pipes, which, as will be



seen from the drawing, are slightly spigoted one into the other. The two parts are drawn together by means of a ring, which grips grooves in the ends of the two pipes. These grooves have inclined faces, and the ring must, according to the inventors, be formed of three, or a multiple of three pieces, to secure concentric tightening. Any expansion of the pipes, under working pressure, is said to improve the tightness of the joint.—*February 7th*, 1929.

306,314. April 3rd, 1928.—MAKING VALVES FOR INTERNAL COMBUSTION ENGINES, H. Pittaway, Belgrave Works, Black Heath, Staffs.

This specification covers a process for the manufacture of valves for internal combustion engines which is claimed to produce a valve that only needs light grinding for finishing. The blank is a length of alloy steel rod of the diameter of the finished stem plus a grinding allowance, and of approximately twice the length of the finished valve. In the first four pressing operations the blank is held in a lower split die which grips it



at a distance up from the lower end slightly less than that of the finished stem. The upper die in the first operation is a tubular die of such a diameter that it thickens up and shortens the upper part of the blank above a shoulder which forms where the head will ultimately be, and the part of the blank immediately below the shoulder is forced into a slightly bell-mouthed part of the lower die, which commences the formation of the usual curved neck at the junction of the head and the stem. The blank is then transferred to the second dies, which carry the thickening one stage further. After this the projecting shoulder which has been extruded between the dies is removed as the metal of this shoulder is overstrained. The blank is then re-heated and passed through the third and fourth dies. On leaving the fourth dies the neck is fully formed, and the metal above it is in the form of a short thick truncated cone. The shoulder which has formed at the bottom of this cone is removed and the blank is cleaned of scale, re-heated, and dropped into a closed die in which the stem and neck are a good fit. A top die having the form of the finished head is then brought down and presses the metal above the neck into the required form.—*February 21st*, 1929.

Forthcoming Engagements.

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Wednesday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

THURSDAY, APRIL 4TH.

ROYAL AERONAUTICAL SOCIETY.—At the Royal Society of Arts, John-street, Adelphi, London, W.C. 2. "The Handling and Mooring of Airships," by Major G. H. Scott. 6.30 p.m.

FRIDAY, APRIL 5TH.

INSTITUTION OF ELECTRICAL ENGINEERS.—Savoy-place, Victoria Embankment, London, W.C. 2. Meter and Instrument Section meetings. "Some Technical Considerations concerning Power Factor in Relation to Tariffs," by Mr. E. W. Hill. 7 p.m.

SATURDAY, APRIL 6TH.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS: YORKSHIRE DISTRICT.—Town Hall, Leeds. Resumed discussion on the address by Mr. W. J. Hadfield on "The Local Government Bill and the Municipal Engineer, with Particular Reference to the Compensation Clauses." 2.30 p.m.

MONDAY, APRIL 8TH.

SURVEYORS' INSTITUTION.—12, Great George-street, Westminster, London, S.W. 1. "The Education of a Young Surveyor," by Mr. B. W. Adkin. 8 p.m.

TUESDAY, APRIL 9TH.

INSTITUTE OF MARINE ENGINEERS.—85–88, The Minories, Tower-hill, London, E. 1. Joint lecture, "The Relative Merits of Pulverised Fuel and Mechanical Stoking and their Application for Marine Purposes," by Mr. W. E. Woodeson, jun., for pulverised fuel, and Mr. J. S. Gander, for mechanical stoking. Discussion. 6.30 p.m.

INSTITUTION OF AUTOMOBILE ENGINEERS.—At the Royal Society of Arts, John-street, Adelphi, W.C. 2. "Automatic Spark Advance," by Messrs. H. S. Rowell and C. G. Williams. 7.45 p.m.

INSTITUTION OF ENGINEERS AND SHIPBUILDERS IN SCOTLAND.—39, Elmbank-crescent, Glasgow. "Experiences with and Investigations on Double-acting Airless-injection Diesel Engines," by Dr.-Ing. F. Sass. 7.30 p.m.

INSTITUTION OF PETROLEUM TECHNOLOGISTS.—At the House of the Royal Society of Arts, John-street, Adelphi, W.C. 2. "The Oil and Gas Fields of Burma," by Dr. L. Dudley Stamp. 5.30 p.m.

WEDNESDAY, APRIL 10TH.

INSTITUTION OF ELECTRICAL ENGINEERS.—Savoy-place, Victoria Embankment, London, W.C. 2. Wireless Section meeting. "Short Waves," by Mr. T. L. Eckersley. 6 p.m.

INSTITUTION OF MINING AND METALLURGY.—Hotel Cecil (Victoria Hall). Annual dinner. 7.45 p.m.

THURSDAY, APRIL 11TH.

INSTITUTE OF METALS: LONDON LOCAL SECTION.—In the Rooms of the Society of Motor Manufacturers and Traders, Ltd., 83, Pall Mall, S.W. 1. Annual general meeting, followed by an open discussion on "Hardness Testing," opened by Dr. G. A. Hankins. 7.30 p.m.

FRIDAY, APRIL 12TH.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS.—West Midland district. Visit to the Stanton Ironworks, near Nottingham. 11.45 a.m.

SATURDAY, APRIL 13TH.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS.—Joint meeting of the Yorkshire and North-Western Districts in the College of Technology, Room C 10, Sackville-street, Manchester. "Local Government Bill, with particular reference to the Road Clauses," by Mr. W. J. Hadfield. 2.30 p.m.

MONDAY, APRIL 15TH.

INSTITUTION OF ELECTRICAL ENGINEERS.—Savoy-place, Victoria Embankment, W.C. 2. Informal meeting. Discussion on "Power Supply and Railway Electrical Signalling," to be opened by Mr. M. G. Tweedie. 7 p.m.

WEDNESDAY, APRIL 17TH.

INSTITUTE OF METALS: SWANSEA LOCAL SECTION.—In the Thomas Café, High-street, Swansea. Annual general meeting. 7 p.m.

THURSDAY, APRIL 18TH.

INSTITUTION OF AUTOMOBILE ENGINEERS.—Technical Institute, Park-street, Guildford. "Central Lubrication of Chassis Bearings," by Mr. H. W. Pitt. 7 p.m.

MONDAY, APRIL 22ND.

INSTITUTION OF AUTOMOBILE ENGINEERS: NORTH OF ENGLAND CENTRE.—The University, Sheffield. "Recent Developments in the Study of the Fatigue of Metals," by Dr. H. J. Gough. 7 p.m.

TUESDAY, APRIL 23RD.

INSTITUTION OF AUTOMOBILE ENGINEERS.—The Engineering and Scientific Club, Queen-street, Wolverhampton. "Central Lubrication of Chassis Bearings," by Mr. H. W. Pitt. 7.30 p.m.

I.E.E. BENEVOLENT FUND.—The late Dr. C. S. du Riche Preller, M.I.E.E., of Edinburgh, bequeathed by his will the sum of £100 free of duty to the Benevolent Fund of the Institution of Electrical Engineers.

BRITISH WATERWORKS ASSOCIATION.—The summer meeting of the British Waterworks Association will be held at Portsmouth on Tuesday to Friday, July 2nd to 5th, 1929, at the invitation of the chairman and directors of the Portsmouth Waterworks Company. The company's works at Farlington, Havant and Bedhampton, and also the pumping station of the Southampton Corporation at Otterbourne, will be inspected.